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ROLE OF UNIVERSITIES IN ADULT EDUCATION

WE have already discussed (*Nature*, May 2, p. 759) some general aspects of adult education in Great Britain, and suggested that the time has now come for fresh thinking on the subject. A shrewd contribution to that end has been made by Dr. H. P. Rickman, of the Department of Adult Education in the University College of Hull, in the March issue of *The Fortnightly*. Dr. Rickman is convinced that adult education is the very life-blood of democracy, and believes that the Workers' Educational Association can provide an unbiased liberal education to enrich personalities and produce better citizens. It cannot at the same time, however, extol one social class and claim itself to be its representative, and Dr. Rickman believes that that part of Prof. R. H. Tawney's summons for a return to strong working-class membership of the Workers' Educational Association is mistaken. Objective teaching cannot be based on class education, but should aim at bringing together, rather than separating, the different sections of the community.

The changed character of the Workers' Educational Association, on this view, is an asset and not a drawback. It fits the Association to supplement the educational system of Great Britain without class distinction, which we are beginning to achieve, by providing adult education on the widest possible basis, and in doing so to offer some correction to the deadening uniformity which some quarters are seeking to impose. Dr. Rickman challenges boldly the doctrinaire and flimsy reasons for stressing the narrower 'workers' conception of the movement, and points the way to a fresh advance through bringing imagination, courage and critical thinking to bear on the new problems.

Dr. Rickman's views find some support in the Unesco Survey, "Universities in Adult Education"*, particularly in Prof. S. E. Raybould's study and in the admirable introduction by Mr. C. O. Houle. The latter attempts to bring out the common features and the underlying principles of policy which emerge in Prof. Raybould's account of British experience, Dr. E. A. Corbett's account of university extension education in Canada and that by B. M. Woods and Helen V. Hammarberg of university extension education in the United States of America, which constitute the rest of the book. Dr. Corbett gives us little more than a long list of Canadian activities in this field, with some historical notes. Mr. Woods and Miss Hammarberg make more effort to distil the lessons of American experience ; but on the whole it is the diversity of experience and the differences in practice in the three countries that are most manifest from the three separate studies.

Mr. Houle's introduction gives something more than unity to the book : it brings out the relevance at a time when, particularly in Great Britain, the

* Universities in Adult Education. (Problems in Education, 4.) Pp. 172. (Paris : Unesco ; London : H.M. Stationery Office, 1952.) 8*s.* 6*d.* net.

purpose and methods of adult education demand re-examination of the study of foreign institutions in order to determine the basic principles which underlie their effective operation. Although Dr. Corbett's survey does not indicate the cultural differences and historical associations of which full account must be taken in arriving at any such principles, the other two surveys at least offer a tentative approach. Indeed, Prof. Raybould quite as much as Mr. Houle stresses the need for investigation not only into the history of adult education institutions, but also into the nature of the educational process in mature persons. In doing so, moreover, he recognizes the promise which such developments hold—particularly perhaps inquiry into history, psychology, methods and comparative study—for a fuller understanding of the essential nature of adult education, its special problems, and the contribution it may make to the development of democratic societies.

To some extent the need for such inquiries has been recognized in the United States also; but, at least in Britain, Prof. Raybould is right in suggesting that along such lines the extra-mural departments of universities may become university departments of adult education in fact as well as in name; while the research itself provides a framework of theory in which the experiments in the training of tutors that most such departments have conducted become an established part of the service rendered by universities to adult education in general. Nor is this the only direction in which Prof. Raybould thinks that the universities could in the future make a distinctive and important contribution. He places first, in fact, the provision, through extension committees, of facilities for students of a different educational and occupational background from that of many Workers' Educational Association students.

In suggesting that this is a field of work for extra-mural departments to cultivate independently of the Workers' Educational Association, and that extension committees, as distinct from joint committees with the Workers' Educational Association, may in future find their chief sphere of activity among the professional classes, Prof. Raybould seems to be ignoring Dr. Rickman's warning and exposing the Workers' Educational Association to further danger of class distinction. Apart, however, from this, it would be a mistaken policy for the universities to concentrate exclusively in their extra-mural work on post-graduate courses of the refresher type. However valuable such courses may be, and although they are undoubtedly proper for a university to provide, such activities should not be undertaken without regard to the other responsibilities of a university towards its region. Selection and discrimination are essential, and it is, above all, important that the universities should not dissipate their available resources by endeavouring to meet all demands made upon them for the provision of adult education.

Mr. Houle, in his introduction to the Unesco publication, formulates five rules which he suggests should guide the universities here. First, the universities should restrict themselves to complex subject-matter: other agencies he considers are better equipped to handle the simpler and rudimentary subjects. Then they should be pioneers, daring in experiment and ready to attempt the pilot study, or in other words to undertake the tasks which voluntary bodies are pre-eminently equipped to attempt. They should provide here, as in other fields, the growing points of society. With these Mr. Houle links the task of training leaders and providing a broad base of leadership at every level of society and in every sphere of activity.

This is clearly a task which in the changed context of the education system of Britain must increasingly fall to the lot of the universities, and accordingly it is important that they should collaborate with the many other agencies in society which provide adult education. An intelligent co-ordination of effort will mean both that the university can illustrate and assist the work of the other agencies, and that it can avoid doing the things which it should not do. Finally, like Prof. Raybould, Mr. Houle suggests that the universities should master adult education as a field of knowledge. The development of research here and the training of leaders will, he recognizes, draw upon and integrate the interests of departments other than education; above all, a dynamic programme of this character demands original thinking and a genuine attempt to re-assess the practices of the past and to adapt them both in relation to the needs of to-day and the resources available.

The universities may well be called upon to make such an effort, and if the recent alarm in regard to the grants for adult education stimulates them to undertake it with some urgency, no harm will have been done. Harm will, however, be done if the stability or the continuance of the extra-mural activities of the universities are endangered, or their planning and development as an essential part of normal university work are hindered. Here, as elsewhere in the universities' work, economy must be practised and retrenchment effected, not on a short-term financial basis, but in relation to the long-term view which alone can avert the disruption and waste caused by sudden and arbitrary cuts.

If, however, the universities are required to consider afresh their precise responsibilities and functions in adult education in view of the widening purpose and growing importance of adult education in general and of the new conditions of to-day, critical thinking and clear vision are equally demanded of the Workers' Educational Association. The Association, moreover, has to reconsider its functions and purpose in the new context, and must face the challenge implicit in the criticism of Dr. Rickman and others. Similarly, we must also expect from the Minister of Education administrative ability, in order to avoid waste of resources and the continuance of means no longer appropriate. Still more, the Minister must have the vision and grasp of essential issues which alone can provide the basis for firm decisions. The committee which is being appointed to make recommendations for the Minister's guidance has a wide field to cover, and the recent discussions will have indicated some of the pitfalls which the formulation of a national policy is likely to meet.

HISTORY OF SCIENCE

A Guide to the History of Science

A First Guide for the Study of the History of Science, with Introductory Essays on Science and Tradition. By Prof. George Sarton. Pp. xviii+316. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1952.) 7.50 dollars.

A History of Science

Ancient Science through the Golden Age of Greece. By George Sarton. Pp. xxvi+646. (London: Oxford University Press, 1953.) 63*s*. net.

STUDENTS of the history of science must sooner or later come across the name of George Sarton, either as an author or in his capacity as editor of the international quarterly *Isis*, one of the most widely read periodicals dealing with the subject. *Isis* was founded by Dr. Sarton, and has been edited by him continuously since it first appeared in 1913 until the end of last year. As well as being a prolific writer, Sarton has lectured on his subject at Harvard almost continuously from 1916 until 1951. In fact, he is one of the select few who have been able to make the study of the history of science their life-work. The publication, almost simultaneously, of two new works from his pen is therefore an event of especial interest.

The first of these works, Sarton would like to be known, for citation purposes, as "Horus", an allusion to the fact that Horus is the son of Isis and Osiris, the latter, of course, being the title of the occasional publication closely associated with *Isis*. Certainly, it can be claimed that "Horus" is, in the literary sense, an offspring of these two publications. This new work serves two purposes. The author first seeks to justify his claim that the history of science as a whole, and not simply that of one or other of the individual sciences, should be more widely studied as a major academic discipline. This thesis is elaborated in three introductory essays, in which, also, he indicates the steps he considers necessary to foster and carry out the teaching of this discipline. The essays are followed by an extensive bibliography, covering the subject in the wide sense indicated.

To deal with the bibliography first, the works listed are placed under four major headings, as follows: *A*, History; *B*, Science; *C*, History of Science; and *D*, Organization of the Study and Teaching of the History of Science. The titles under each of these headings are again divided into sub-headings totalling, in all, twenty-six; and finally each of the secondary headings is further sub-divided. Of the secondary headings, we may mention, as examples, under (*A*), historical methods; under (*B*), scientific methods and the philosophy of science, catalogues of scientific literature, general scientific journals, and national academies and scientific societies; under (*C*), treatises and handbooks on the history of science, history of science in special countries, history of special sciences, journals and serials concerning the history and philosophy of science (with a useful addendum of "Misleading Titles"); and, under (*D*), national societies devoted to the history of science, and the teaching of the history of science. A short introductory note precedes each of the twenty-six main sub-divisions, and many of the individual entries are annotated. Further assistance to users of the bibliography is given by an author index containing upwards of 1,500 names. It is expected that the book will be used mainly by English-reading students, and their needs are given priority by listing suitable books in English, or in English translations, whenever possible. If such are not available, then, in the case of texts in the less familiar languages, French or German translations have been given preference over the originals. The author has refrained almost entirely from the temptation to add remarks critical of particular entries, but has, wherever possible, given references to the critical reviews or short notices published in *Isis*, a course which is probably more satisfactory from the student's point of view.

The bibliography is based primarily on the author's own library, and is supplemented from the bibliographies regularly published in *Isis* (which, by now, it is claimed, must include some 75,000 entries). Some idea of its scope can be gained from the fact that it occupies about 250 pages, and that the number of titles approaches 2,000. At the same time, no claim is made that it is exhaustive, and readers familiar with the subject in general, or specialists in the history of particular sciences, will doubtless call to mind some works that, in their opinion, might deservedly have been included. The author disarms criticism on these grounds with the statement that a general bibliography of this sort cannot do more than assist a scholar; and adds the sound advice that, though every investigation should begin with a bibliography, it ought to end with a better one.

It is regrettable that the author has found it necessary, on the score of labour and expense, to exclude biographies of scientists. These often provide valuable material for students. Users of the bibliography are advised to make their own lists, but this is not an easy task for the inexperienced, particularly if living out of reach of a first-class reference library. Apart from this criticism, the book admirably fulfils the purpose expressed in its full title. It is an excellent guide to the history of science, and is believed to be the only book of its kind. To obtain the information here compressed between the covers of one conveniently sized book, it would be necessary to search the pages of *Isis* for the past forty years. It should prove extremely valuable to students, research workers, teachers, librarians, and in fact to all in any way interested in the history of science, or some special branch of science.

A notice of "Horus" would not be complete without some further reference to the three introductory essays that occupy the first sixty pages or so. These are based on three lectures delivered by the author in Europe, with the express object of explaining the meaning and purpose of the history of science. In the first, entitled "Science and Tradition", Sarton discusses the revolutionary change that has resulted from the major scientific discoveries, not only in our way of life, as a result of their practical application, but also in our outlook on the world as a whole, and on the universe around us. The change, he states, though it has taken place slowly, is one from a science ancillary to theology, or divine revelation, to the modern conception of science as the search for truth irrespective of its consequences. Sarton's fear is that, accompanying this change, the destruction of good traditions is taking place concurrently with the elimination of the bad ones. He is apprehensive that we are passing into an age in which the rule of technocrats rather than that of true scientists is in the ascendant. He concludes this lecture by pointing out that, while most educated people realize the need for the study of history for political purposes, they do not yet realize its function in the reconciliation of

science with the humanities, or for the humanization of science.

The second lecture has a somewhat misleading title, "The Tradition of Ancient and Mediæval Science", and might more aptly be called "The Transmission of Ancient Science through the Ages". In it the author discusses the fragmentary and incomplete state of our knowledge of the science of the ancients, that is, broadly speaking, of science as it existed before the invention of printing stimulated the accurate recording and wide distribution of knowledge. Much has been lost, but it is still possible that our knowledge of this early period may yet be enlarged through the patient study of old manuscripts and inscriptions by philologists and archæologists.

Sarton hopes, by means of his first two lectures, to persuade his readers that it is worth while teaching the history of science; but he admits that acceptance of this view will not be universal, and may not be general. In his third lecture he discusses whether, in fact, it really is possible to teach the history of science, as a whole, as distinct from the histories of particular sciences, which, not surprisingly, have a much wider appeal. He indicates the nature of the opposition likely to be encountered. There are, first of all, those who reject the past as something not worth worrying about, being permanently finished. Secondly, there are those scientists who realize the importance of political and social history, but are not interested in the history of science, because the scientific ideas of the past are definitely inferior to those of the present, and therefore would not repay the effort of studying them. They are concerned only in the perfectibility of science. These two groups, Sarton feels, are historically blind, and there is no hope of overcoming their lack of interest.

Into a third group Sarton places those ignorant, and therefore dangerous friends, men of science, perhaps a majority, who admit an interest in, and may even be enthusiastic about, the history of science, but scarcely realize the necessity of studying it. They regard it as a relatively simple matter, and uncritically accept as good any book on the subject (how they can do otherwise without making a special study of the subject is not stated). This latter class, Sarton claims, quite fails to realize the difficulties in the way of arriving at truth in historical matters; or that, though history may be easy to read, it does not follow that it is easy to write. Sarton thinks they will only too readily answer that it is possible to teach the history of science, but will dismiss it as a task so easy that it can safely be left to inferior minds.

Sarton's thesis is that historians of science must know both science and history, and that the most perfect knowledge of one is insufficient without some understanding of the other. He claims that a historian of culture is not qualified to discuss the history of science if he lacks any kind of scientific training and, similarly, that even the most distinguished men of science are not qualified to discuss the history of their subject if they lack historical sense. Good intentions are not enough, and, Sarton states, there are few historians of science fully qualified for the task of teaching their subject. It is all a matter of training; but the training, if different from that ordinarily required for a historian or a scientist, is not necessarily more difficult. Nevertheless, if it is to be taken seriously, there can be no doubt that the history of science as a whole must be regarded as a major discipline.

This is the counsel of perfection, but it is a thesis that ought ultimately to receive universal acceptance, as general interest in and knowledge of the history of science grows, and there are encouraging signs that it is growing, even among professional historians.

Sarton's other, his latest, work on the history of science goes back to the Golden Age of Greece, when philosophers had more time to think, talk and speculate. Those who know the author's earlier three-volume "Introduction to the History of Science" will, no doubt, wish to know what is the relation of the latter to this new product of his pen. The "Introduction", a work covering the period from antiquity up to A.D. 1400, is an elaborate treatise and bibliography, a reference work not intended as a book to be read straight through. The new work, on the other hand, is intended to meet the needs of students and general readers, rather than those of the research worker. It contains the essence of the course lectures given by Sarton at Harvard during the past thirty years or so. Though complete in itself, it is only the first of a series of eight volumes in which the author intends to take his reader up to the present day, and covers, in time, only the period from the dawn of history until the end of the fourth century B.C. It specifically excludes any special study of early Hindu and Chinese science, not because these are without importance, but on the ground that they lack significance for Western scientists, whose thinking has been influenced mainly by Hebrew and Greek thought, and scarcely at all by that of the Chinese and the Hindus.

This book cannot be noticed in detail here, but the name of the author is sufficient guarantee that perusal will be rewarding; and industrious readers will no doubt look forward to the appearance of the further volumes promised. They will form a fitting monument to Sarton's life-work.

BIOCHEMISTRY OF PHOSPHORUS COMPOUNDS

Phosphorus Metabolism

A Symposium on the Role of Phosphorus in the Metabolism of Plants and Animals. Vol. 1. Sponsored by the McCollum–Pratt Institute of the Johns Hopkins University. Edited by William D. McElroy and Bentley Glass. (Contribution No. 23 of the McCollum–Pratt Institute.) Pp. xv+762. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1951.) 80*s*. net.

EVEN the briefest account of major advances in biochemistry during the past two decades could not fail to include the developments in the chemistry and physiology of phosphorus compounds; for in this field we have witnessed truly spectacular progress. Looking back, however, one cannot but be impressed by the successive changes in the attitude of biochemists towards the role and the mode of action of phosphorus compounds in Nature. Thus, for example, about 1930, it was popular to discuss the concept of 'energy linkage' ('energetische Koppelung'); this notion, while it attributed to a phosphorus-containing coenzyme such as adenosine-triphosphate the position of an agent which plays a part in energy exchange, did not, however, provide any material basis for the actual mechanism of this process. From 1934 onwards that somewhat vague

idea of 'energy linkage' acquired a new meaning with the discovery of the 'Lohmann reaction' and 'Parnas reaction', when it was demonstrated for the first time that adenosinetriphosphate is involved in a direct intermolecular shift of phosphate groups, from the phosphorylated intermediary products of glycogenolysis to creatine. For some years following these findings the term 'energy linkage' was largely abandoned in favour of the concept of 'chemical linkage'; before long, however, it emerged again (1941), this time in an entirely new guise, with emphasis on the phosphate bonds in adenosinetriphosphate as the site at which the free energy is stored, and whence it can be dispensed in response to the demands of metabolic processes.

Another significant change concerning the phosphorus-containing coenzymes, which began to take shape more recently, has been the growing awareness that the function of these substances is by no means restricted to the metabolism of carbohydrates, but that they are instrumental also in the decarboxylation and transmethylation of amino-acids, the synthesis of peptide bonds, carbon dioxide fixation, photosynthesis, oxidation of fatty acids, formation of acetylcholine and certain other acetyl-transfer reactions. In fact, with discoveries in the field of phosphorus compounds and phosphorylations following each other at an ever-increasing pace, there remains scarcely a branch of biological chemistry which could claim to have escaped their impact. Nothing can illustrate the above statement in a more realistic and convincing manner than the symposium on phosphorus metabolism held in June 1951 at the McCollum–Pratt Institute in Baltimore, the proceedings of which have now appeared as a book containing no fewer than fifty papers dealing with different aspects of phosphorus metabolism in plants and animals. These are by no means conventional review articles. They are surveys by specialists who were recruited from among active investigators intent on reporting and discussing not so much what was being done by others, but rather the results of their own original research. Each subject is introduced on a broad basis by one speaker, and then elaborated further by additional contributions of several other investigators.

The subjects thus covered include the metabolism of polysaccharides and disaccharides (Hassid, Doudoroff, Hehre, Sutherland), fructose (Slein, Taylor), hexosephosphates (Leloir, Cohen, Lipmann), triosephosphates, pentosephosphates (Horecker, Racker, Dische) and nucleosides (Lampen, Schlenk); the biochemistry of inorganic pyrophosphates and metaphosphates (Schmidt), coenzyme A (Novelli), pyridoxal phosphate (Gunsalus) and uridine pyrophosphate compounds (Park); the metabolism of phosphorus-containing coenzymes (Kornberg); the role of inorganic ions in phosphorylations (Lardy, Najjar); thermodynamics of phosphate bonds (Lipmann, Oesper, Koshland); a series of articles on acetyl-transfer reactions (introduced by Barker), and another on oxidative phosphorylations (Hunter, Green, Lehninger and others); and finally, a number of particularly interesting papers grouped together under the title of "Utilization of Phosphate Bond Energy in Biological Systems", which includes contributions on muscular contraction, bioelectricity, bioluminescence, synthesis of peptide bonds, carbon dioxide fixation and transmethylations.

The symposium exhibits several commendable features; in particular, it deserves praise for the skilful avoidance of overlapping in the treatment of the various subjects, and the care with which it has been edited and published; the inclusion *in extenso* of the discussions greatly enhances its value, especially to those actively engaged in this or in allied fields. It can be said without exaggeration that in its peculiar collective form it is one of the most comprehensive treatises on the subject of phosphorus metabolism available at present.

T. Mann

CLIMATOLOGICAL MAPS FOR THE BRITISH ISLES

Climatological Atlas of the British Isles

(Air Ministry: Meteorological Office. M.O. 488.) Pp. vii+139. (London: H.M. Stationery Office, 1952.) 52*s*. 6*d*. net.

A COMPREHENSIVE climatological atlas of the British Isles has long been awaited, for, since the days of Buchan, Mill and Bartholomew, a steadily growing mass of standardized observations has arisen to satisfy the public need. In this atlas the incidence and distribution of ten major climatic elements—pressure, wind, temperature, rainfall, snow, thunder, humidity, sunshine, visibility with fog, and cloud—are very thoroughly delineated in upwards of a hundred and fifty maps and diagrams, printed with clarity and effective colouring. A folding orographical map can be opened for comparison with those of climate, which abound in material for discussion. There is, for example, a splendid set of maps of average means of relative humidity at 13.00 hr. whereon the moist atmosphere of eastern Ireland gives food for thought. Likewise, the unpleasing frequency of winter fog on the Great North Road from Newark to Ferrybridge is sternly revealed.

Climatological mapping for islands so diversified is not easy; on the whole, the compromise here adopted is effective. Yet the drawing of isopleths among an irregular scatter of observations subject to numerous environmental variables is a geographer's technique which is not everywhere evident. Many readers will turn with interest to some of the smaller maps—for example, the enterprising effort to show the average date of the first and last screen frost (p. 48). Misapprehensions may arise here; air masses being what they are, the chances of early and late frosts in the potato country of south Lancashire are, in my opinion, unlikely to be represented by the isopleths here given. Scrutiny of recent data from Strathy or Kettins will soon show that the bleak pastures of Caithness or the broad ploughlands of Strathmore are not given fair representation by the map on p. 49, which shows them receiving less than half the number of frosty nights ascribed to the Eden valley. Maps showing absolute extremes (p. 47) are open to similar criticisms; they might reasonably have been extended to include more stations over a longer period.

Representative temperature data are, however, difficult to choose and map, and the like applies to other climatic elements; moreover, caveats are entered in the text (for example, pp. 31 and 128). Future editions might include diagrams giving approximate corrections for altitude or site factors, as the effects of the latter are tolerably constant. Some further representation of the variability of monthly rainfall would be welcome.

Among minor points, on p. 29 the November extreme up to 1940 should be given as 70° F.; on p. 117 the choice of Cullompton's 1,101 hours of sunshine in 1912 as "lowest on record" is odd when in the same year many stations had both lower totals and lower percentages. On p. 133 the same order of tints has been used to grade both visibility and fog. Misprints, for example Marton on p. 80, are very rare.

The success of the many maps must be set against the few open to criticism. Numerous detailed maps and tables—for example, those showing exceptional rainfalls, sea-breeze effects, and frequency of low cloud and sunny days—are welcome and opportune. Admirable informative notes and useful references are added. The diversity and clarity of the material thus officially presented render this atlas not only indispensable as a reference but also good value; minor points can easily be remedied in a second edition. Such an atlas provides a lively stimulus to all who would discuss the future welfare of Great Britain.

GORDON MANLEY

INDIAN VIEWS ON PLURAL SOCIETY

Caste and Class in India

By Prof. G. S. Ghurye. Pp. vii+246. (Bombay: Popular Book Depot, 1950.) 15 rupees.

Group Prejudices in India

A Symposium. Edited by Sir Manilal B. Nanavati and C. N. Vakil. Pp. 223. (Bombay: Vora and Co., Ltd., 1951.) 17*s.* 6*d.*

PROF. G. S. GHURYE'S "Caste and Class in India" is in effect a second edition of his "Caste and Race in India", published in the "History of Civilization" series in 1932. The chapter (5) on "Race and Caste" in that first edition, and the appendixes which related to it, have been, wisely on the whole, omitted in the present volume, and hence no doubt a change has been necessary in the title. Chapters 8 and 9 in the first edition, called there "Caste: Recent and Contemporary" and "Conclusion", are expanded into Chapters 7, "Caste and British Rule", and 8, "Caste and Nationalism", a ninth chapter being added on "Class, its Role", while there are some other additions in earlier chapters. The first four chapters still constitute an excellent conspectus of the caste system, which Prof. Ghurye is admirably qualified to give, and these form the most valuable part of the book. On the elements of caste outside India he is not quite so happy, as his insistences on parallels with Rome and with medieval Europe, for example, are not really valid. Class distinctions are world wide and have not infrequently involved some restriction of, or even prohibition of, intermarriage between classes; it is the peculiarly Indian element of taboo involving pollution and consequential purification which distinguishes caste from mere class. Prof. Ghurye correctly states that Anglo-Saxon laws laid down a rule of endogamy, but there is very good reason to suppose that 'laws' of that kind merely laid down what the lawgiver regarded as an ideal of behaviour; and, in any event, to go on to say that "by the fifteenth century in England this rule of endogamy had almost vanished" gives a very false impression of English society from the time of King Alfred onwards, to say nothing of any changes due to the Norman Conquest, when Anglo-Saxon laws were superseded by Norman. When dealing with the origin of the caste system, Prof. Ghurye seems to lay too much emphasis on the racial factor, which by itself would no more have given rise to a caste system in India than it has done anywhere else.

In his chapter on "Caste and British Rule", the author indicts the British for not having taken more effective measures to abolish caste and for not having ignored caste in its recruitment to Government service, a policy which, if pursued, would have filled the southern Indian services, at any rate, with Brahmans to the virtual exclusion of other castes. But discriminative recruitment was probably an inevitable corollary of abstention from anti-caste legislation, and that is a measure which, in view of the religious sanctions of caste-observance, would have been contrary to the pledge given by the Crown in 1858, and could in any event only be successful if undertaken by Indians themselves, since caste is still an integral factor in Hindu society, and very strongly entrenched there. When Prof. Ghurye states that ever since the Indian Mutiny "the Indian Army has been studiously purged of the higher castes", he is making a flat misstatement, since many Rajputs and some Brahmans have continuously played an important part in the composition of the Indian Army. Actually lower- (not higher-) caste Hindus had been eliminated from the Bengal Army by 1893, when the 'class' system of recruiting was restored, so that whole regiments consisted uniformly of Brahmans, or of Rajputs, etc. The final chapters amount in effect to an exhortation to abolish caste, and the author is to be commended for realizing that an attempt to return to the four *varna* of the Vedic age, as recommended by Mahatma Gandhi, would be no less detrimental if achieved than it is actually in practice impossible. But he should be more careful in his use of authorities at second hand; a failure to verify his references has led him to ascribe to Sir F. Bartlett words which, though doubtless he would agree with their content, he most certainly never expressed.

Prof. Ghurye is also one of the thirty-one contributors to "Group Prejudices in India: a Symposium", edited by Sir Manilal Nanavati and C. N. Vakil. This volume has the very commendable purpose of focusing the attention of the Indian public on the causes of tension, rivalry, and antipathy between cultural, religious, and economic groups so numerous in Indian society. The contributors are divided into six sections: culture and prejudices, religions and prejudices, social prejudices, politics and prejudices, minorities and prejudices, and miscellaneous. Unfortunately, the contributions are extremely uneven and, together with a few objective and useful contributions to the study of, and therefore towards the elimination of, prejudice, there is some sermonizing, a good deal of rather frothy platitude, and some sheer fustian. Generally speaking, the contributors blame Great Britain for encouraging group antagonism by a deliberate policy of 'divide and rule', and although the editors point out that the political unity of the Indian peninsula was first brought about by British rule, one contributor goes so far as to accuse the British of having deliberately created in 1917 the non-Brahman versus Brahman antagonism in south India, which had become vocal at least as early as 1840. Writers seeking to eliminate prejudice would carry more weight and sound more convincing if they refused to be blinded by it themselves.

J. H. HUTTON

Wörterbuch der mathematischen Wissenschaften

Band 1: Deutsch–Englisch. Von Dr. Leo Herland. Pp. 235. (London: Hafner Publishing Co., Ltd., 1951.) 24*s*.

THIS book is a first attempt to fill a need long felt by mathematicians for a specialized technical dictionary. It will be of considerable help to research students who, with little previous knowledge of German, are faced with the task of reading a good deal of mathematics in German, such as the "yellow-backs" or "Ergebnisse" tracts. The book is well produced. A large type has been used in the printing, and this makes for unusual clarity. Numerous cross-references are given under many of the key words which occur in widely differing branches of the subject, and altogether the author has produced a commendable and relatively complete work.

However, there are some serious omissions, such as the following. The words *Verband*, *schlicht*, *Zelle* and *Spaltung*, all commonly occurring in non-specialized branches of mathematics, are missing. In geometry, which the author curiously emphasizes by separating it from the main stream of mathematics, the omissions are particularly serious. Examples are *Hauptdreikant*, *Doppelgeschlecht*, *Leitkurve* and *Restschnitt*. It would help a geometer if, under cross-referencing, the words *Konstantenzahl*, *Hüllfläche* and *adjungierte Fläche* appeared. And what about *abzählende Geometrie*? This does not appear under *Geometrie*, and for *abzählen* the meanings given are 'count, denumerate', but not the usual translation 'enumerate'. Incidentally, I cannot find the verb 'denumerate' in the "Oxford Concise Dictionary", so this translation of *abzählen* is not to be recommended on the grounds of common usage. Another word, *Auflösung*, is used in algebraic geometry to refer to the 'resolution' of singularities, but no cross-reference to this is made. Apart from omissions such as these, there are some incorrect translations: *perfekt* (algebra) should be 'complete', and *mehrdeutig* in function theory is, literally, 'many-valued' and not 'ambiguous'.

If these omissions and errors can be rectified in a second edition, the book should be in great demand among mathematicians.

L. S. GODDARD

Physics as a Career

By Norman Clarke. Pp. 70+9 plates. (London: Institute of Physics, 1952.) 6*s*. net.

THE author of this book, Mr. Norman Clarke, is the deputy secretary of the Institute of Physics and he has spent most of the past seven years, as he reminds the reader in the preface, talking, writing and listening to physicists, intending physicists and employers of physicists; this fact should be sufficient to commend the book as a useful and authoritative guide to those seeking a career in physics. In addition, as many members of the Institute can testify, particularly those who have consulted Mr. Clarke with regard to problems concerning salaries, conditions of employment and training, and in connexion with applications for posts as physicists, his sound advice and wide experience have been invaluable. His knowledge with regard to these matters is now made available to a wider public, and it is to be hoped that it may stimulate those who have the talents to study and take up professional careers in physics.

The author deals briefly, in separate sections, with physics and its applications, professional education and qualifications, posts in industry, the universities, government service, technical colleges, schools, research associations and work as hospital physicists. Details of the salaries and prospects of promotion in these various posts are clearly stated. In the four appendixes, useful factual information regarding technical colleges recognized by the Institute of Physics as training centres, and the various research associations of the Department of Scientific and Industrial Research, is given, in addition to a short bibliography of books about science, and the addresses of the various physical societies and associations of physicists. The illustrations are interesting and lend tone to the book, but are superfluous to the text.

Under the Red Sea

By Hans Hass. Translated from the German by James Cleugh. Pp. 208+47 plates. (London: Jarrolds Publishers (London), Ltd., 1952.) 16*s*. net.

CONSIDERABLE publicity is being given in the popular press to the possibilities of leaving this earth to explore worlds beyond our own. Much more accessible than Mars or the moon, however, is a world on which man has still barely set foot: the world beneath the seas, where "the surface of the water is the sky . . . and the waves are its clouds". The fascination and enchantment of it can be judged from some of the superlative photographs which liberally illustrate this book by Dr. Hans Hass. Outstanding are a series of nine pictures of the manta, *Manta birostris* Walbaum. Very great credit, too, must be given to the author's courage and considerable swimming skill in obtaining these.

Unfortunately, it is the photographs alone which commend "Under the Red Sea" to the serious attention of biologists. The text contains little of scientific worth and presents, for the most part, a rather trite and superficial account of the author's brief acquaintance with the Sudan, the Sudanese and its British officials. Quite unexpectedly, however, there are here and there passages of vividly descriptive writing, as when he portrays some exquisite coral land- (or sea-?) scape, or in describing the sensations of being alone in this underwater world with a myriad of animals of unknown habits. At such times he writes with a passion for this environment as great as that of a countryman writing of the countryside he loves.

ALAN J. BROOK

Les négritos de l'Ile de Luçon (Philippines)

Par Dr. E. Genet-Varcin. (Ouvrage publié sous les auspices de la Société d'Anthropologie de Paris.) Pp. 260. (Paris: Masson et Cie., 1951.) 1200 francs.

THIS is a study of the pygmy skeleton, with special reference to material from the Philippine island of Luzon. The material consists of the remains of fifteen adult males, fourteen females, two adolescents and five infants and is probably the most complete collection of Negrito skeletons yet made, or ever likely to be made. It is a great pity, therefore, that the measurements of the individual crania and other bones have not been included, as this omission makes the publication useless for comparative studies making use of modern biometrical techniques. Mean measurements when based on such a small sample can be very misleading, and this criticism applies even more strongly when they are compared with means relating to other groups of pygmies where the numbers on which the means are based are even more inadequate—in some cases merely a single specimen. Any conclusions derived from this study must therefore be regarded as hypothetical until they can be supported by more complete data.

G. I. JONES

SCIENTIFIC INSTRUMENTS FOR RESEARCH AND INDUSTRY

PHYSICAL SOCIETY'S EXHIBITION, 1953

THE thirty-seventh annual exhibition of scientific instruments, organized by the Physical Society, was opened by the president of the Society, Prof. R. Whiddington, on April 13. After thanking the governors and heads of departments of the Imperial College of Science and Technology, London, for continuing to allow the use of the College for the purposes of the exhibition, he remarked, "I feel certain that those whose hospitality we enjoy feel, with the Council of the Physical Society, that this exhibition not only meets a need but also does a most useful service to the community which we are all in our several ways trying to serve. . . . Whenever, in recent years, I look through the Handbook, I am reminded of the time when, as a young man, forty years ago I started research at the Cavendish Laboratory, Cambridge, on a topic to do with electrons. I was warned by certain well-meaning friends of the serious mistake I was making in entering a field destined in the near future to become arid, dull and uninteresting. How wrong they were! In looking through the 300 or more pages of our Handbook, what a large number of exhibitors are connected in one way or another with applications of particle physics, in particular electron physics. This is not the time or place for me to compare the work of the modern electron physicist with that of his forbear in physics of the last century, though it is interesting to reflect even for a moment, as I hasten to say we are now doing, on the many similar principles used in both eras. The results to-day are really staggering, whether you look at the university laboratory devoted in the main to research for its own sake, or the industrial and service research laboratories where equal fun and interest is to be found, but where applications are made more directly to human amenities and defence. I firmly believe, and I am sure that all with knowledge of the position will agree with me, that this exhibition does much to show the scientific world what apparatus and instruments are available—and what books are available—to help in the great work".

The exhibition was open for five days, April 13–17 inclusive. The numbers attending amounted to twenty thousand, their entry being automatically recorded as 'persons per minute' during every minute while the exhibition was open, that is, from 10 a.m. to 8 p.m. including the lunch hour. This time only one exhibit was housed in the Huxley Buildings, the main exhibition being staged in the Imperial College.

Three discourses were delivered by eminent scientific authorities: (1) "Seismic Study of the Ocean Basins", by Dr. E. C. Bullard, director of the National Physical Laboratory, Teddington; (2) "Particles, Pellicles; Pigments, Paints and Physics", by Dr. L. A. Jordan, director of the Paint Research Station, Teddington; and (3) "Scintillation Counting and its Medical Applications", by Prof. W. V. Mayneord, head of the Department of Physics, Royal Cancer Hospital, Fulham Road, London.

Dr. Bullard's discourse was given on Tuesday evening, April 14. After referring to geological methods used in studying the solid earth above sea-level, he pointed out that direct information about the geological structure of the floor of the deep oceans is necessarily meagre. The rocks are not only hidden under several miles of water, but are usually also covered by several thousand feet of sediments. Oceanic geology has therefore to be carried on by indirect methods, and conclusions drawn from the frequently ambiguous indications of gravity, magnetic and seismic measurements. Of these, the seismic give the most detailed information. The first marine seismic observations were made before the Second World War in the relatively shallow seas covering the continental shelf on both sides of the Atlantic. Since the War the work has been extended to the deep oceans, and results of great interest for geology have been obtained. In shallow water the instruments can lie on the bottom, but in deep water this becomes impracticable and a method is used in which both the explosive and the receiving device are suspended at a depth of only a few hundred feet from the surface. The receivers are hydrophones hung beneath buoys fitted with radio-transmitters. Results have been obtained up to distances of 80 miles using only a few hundred pounds of explosive. They show the structure of the greater part of the oceans to be quite different from that of the continents. The discontinuity which occurs at about 35 km. under the continents, and represents the base of the earth's crust, is only about 5 km. below the floor of the oceans. The sediments in the oceans are not so thick as had been generally supposed and are usually less than 3,000 ft. in thickness, as compared with 8,000–16,000 ft. over the continental shelf. From the measurements of velocity in the various layers below the ocean, the 5-km. layer of rock underlying the sediments is supposed to be basalt (velocity 6·5 km./sec.), whereas the deeper-lying basic rock, having a higher velocity of sound (8·1 km./sec.), is probably olivine. The results at present available represent only a few points scattered over a vast area, but nevertheless are of great significance for geological theory.

The second discourse, by Dr. L. A. Jordan, was given on Wednesday evening, April 15. He illustrated the importance of physical considerations in research applied to paint technology, by noting the transition from the general particle to the particular pigment in terms of crystalline nature and structure, and the effects of refractive index and other physical conditions on colour and special properties as well as on general behaviour. Similarly, considerations of the media used in paint technology were shown to bring in rheological considerations and other aspects of classical physics. It was shown that particle size has a profound effect on the colour shade of a pigment, and that large apparent variations of colour can be produced as the colour of the background is varied. Dr. Jordan directed attention to the infra-red and ultra-violet reflexion from paints and referred to the importance of these factors on the painting of tanks exposed to desert heat, and to ships' camouflage. Viscous and elastic properties of paints can be measured by a torsion pendulum method, and the weathering properties were illustrated by electron microscope photographs. In considering the flow properties of paints, it was pointed out that they are non-Newtonian fluids showing thixotropic behaviour. The conjunction of pigment and medium, constituting paint, brings notable forces into play. Examples were shown of carbon black in oil forming equispaced parallel 'diffraction' lines, mottling effects

during flotation, and the effects of temperature gradients during flotation. Pigment flotation in paints regarded as a dynamic phenomenon has been the subject of special study at the Paint Research Station. A cinematograph film illustrating this work was shown. A striking effect 'like oil on troubled waters' was shown when a trace of silicone fluid was introduced into the surface of a pigment–oil mixture, all trace of cell formation (mottling) being immediately destroyed.

Prof. W. V. Mayneord delivered the third discourse on Thursday evening, April 16. He pointed out that the use of crystalline and liquid scintillating media in conjunction with electron multipliers has now become an important technique in modern physics. He outlined the development of the subject and discussed the underlying physical principles. The high sensitivity of the system for a detector of small linear dimensions makes the method applicable to a number of important problems. As a proportional counting system, the scintillation method has applications in gamma-ray and particle spectroscopy. Prof. Mayneord described applications of scintillation counting to the detection and measurement of radioactive isotopes introduced into the human body, including recent attempts to form visual and photographic images of the spatial distribution of radioactive materials. The importance of such applications to cancer research is obvious.

Details of the exhibits and demonstrations staged by about 150 exhibitors are to be found in the Physical Society's "Handbook of Scientific Instruments and Apparatus, 1953"*. This handbook is essentially a reference book, well printed on art paper and profusely illustrated by half-tone reproductions, valuable to all those interested in the use of scientific instruments in industrial, 'service', or academic research and in the teaching of science in schools and technical colleges. The exhibits cover the whole field of scientific instruments and the materials used in their construction; the exhibitors include a large number of industrial firms, the government research laboratories and some university laboratories.

On this occasion a tour of the exhibition revealed a welcome increase in the number of 'dynamic' exhibits (that is, demonstrations, or working models) relative to 'static' (that is, not functioning) exhibits. Although there is, of course, much of interest in static exhibits, a simple demonstration is always more attractive and often more convincing. With such a large number of interesting exhibits it is not possible in this brief review to mention more than a few, picked more or less at random. Inventive ingenuity was often displayed not only in the instruments themselves but also in their names, for example, holiday detector, psophometer, xerograph, etc. A 'holiday' is, in fact, a pin-hole in the protective coating of a steel pipe-line. If such pin-holes are not detected and filled before the pipe is buried in the ground, they form a possible source of corrosion. Pre-heating the gas and air supply to a bright-red heat makes it possible to use a gas–air hand-torch to melt a 1-mm. diameter platinum wire. The torch is very convenient for brazing and copper-soldering. A reciprocating drill operated at ultrasonic frequency, using a magnetostrictive transducer at 22 kc./sec., is used for the rapid drilling and cutting of brittle materials when a paste of carbide abrasive is fed to the vibrating tip. The absence of any rotary motion renders this type of instrument particularly useful for drilling holes of any required shape and for making cuts and depressions in materials which are difficult to machine by more conventional methods. A square hole was cut in a thin plate of glass in a minute or so. Two types of watch rate-recorder were exhibited, the first being a cathode-ray tube indicator and an oscillator of variable frequency adjusted in such a manner that the rate of the watch could be read off directly from a dial. The second type is a printing machine, which records the watch ticks on a tape carried by a small synchronous motor controlled from a crystal oscillator. This system not only gives the rate of the watch but also permits of detection of faults in the movement to a high degree of accuracy. The Science Museum, South Kensington, exhibited the original Milne–Shaw seismograph designed in 1914; instruments of this type are easily maintained and are used extensively for general recording purposes at seismological stations throughout the world. As usual, a wide range of vacuum pumps and vacuum equipment accessories was on view.

A demonstration was provided to illustrate the strain-free cutting of soft metals when it is desired that the cut edge shall be free from strain, as in the X-ray determination of preferred orientation. The method consists in the removal of positive ions from the workpiece by an electric condenser discharge across a small gap to the cutting electrode and quenching the discharge in oil. This produces a precision cut, free from strain. A general purpose digital computer for mathematical and scientific work employed a rotary magnetic disk as a 'store'. Dynamic storage in the registers of the arithmetic units was obtained by magnetostriction delay lines. With this arrangement combined with an electric typewriter, tables of sines and cosines for every degree up to 90° could be worked out in a few seconds and typed out to nine places of decimals in a few minutes. The high speed of the machine was also demonstrated in tabulating the second, third and fourth powers of numbers. The Imperial College Mathematics Department demonstrated a large automatic computing machine performing all the basic operations of arithmetic on 20-digit binary numbers. This was housed in the Huxley Building, Exhibition Road. The Hydraulics Research Station (Department of Scientific and Industrial Research) exhibited a wave-height analyser in operation. This device measures each wave from a trough to the following crest using a series of probes dipping into the water. The result is recorded as a count on one of thirty-two telephone message registers and stops after 300 waves. The effective wave-height and the height distribution can then be determined. A roundness-measuring machine for examining the roundness of such parts as balls and rollers, ball and roller races, pistons and cylinders, with electrical indication of departure from ideal was shown to give magnifications of inaccuracies in steps from 50 to 10,000. An ingenious device for measuring air flow (as a spirometer for use with small animals) was shown by the Chemical Defence Research Establishment (Ministry of Supply). The air-flow carries a soap film along a tube towards a pair of electrodes at the exit end. Connexion of the electrodes by the soap film operates a relay and counting

* Handbook of Scientific Instruments and Apparatus, 1953, as shown at the 37th Physical Society Exhibition. Pp. xii+262+A72. (Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.) 6s.; by post, 7s. 3d.

system which records the event, breaks the film and creates a new film at the inlet end of the meter. Another demonstration by this Establishment showed how large drops of liquid can be freely supported in an upward stream of air. The technique employed for this purpose has been used successfully in an investigation of the mechanism of atomization when freely supported drops are shattered by high-speed air streams.

In the ultrasonic field a number of exhibits showed the latest developments in barium titanate transducers for flaw detection, high-power treatment of liquids, etc. It is well known that the amplitude of a tuning fork must be constant to maintain an accurate frequency. A fork was shown which incorporated a novel device for maintaining a constant amplitude. It was also shown how a sinusoidal e.m.f. of constant frequency could be derived from the vibrating fork. An attractive exhibit staged by the Signals Research Establishment (Ministry of Supply) demonstrated the synthesis of speech from signals having a low 'information-rate'. Slowly varying parameters specifying the resonant frequencies of the vocal cavity system and the excitation applied to it serve to produce synthetic speech of good intelligibility. A somewhat unusual type of exhibit combined a chemical balance with an electric furnace for the study of change of weight during a prolonged heating process. A two-pen electronic recorder registers the variation of weight during the process. The Royal Aircraft Establishment (Ministry of Supply) showed the operation of a pyroheliometer for use in aircraft, designed to measure the solar radiation incident on the aircraft while in flight. In another exhibit, by the Services Electronics Research Laboratory, it was shown that amorphous selenium, which is opaque in the visible region, transmits radiation in the range from the near infra-red to centimetre wave-lengths. Optical components such as lenses and prisms can be made by simple casting techniques.

The Technical Optics Section of the Imperial College gave a fine series of demonstrations of optical devices. Perhaps the most popular of these was the one dealing with stereoscopic photography and projection. The photographs were taken with a 'Verascope' camera and projected with a pair of Aldis film-strip projectors through 'Polaroid' filters. The three-dimensional picture was viewed with 'Polaroid' spectacles. The projectors were provided with various adjustments for controlling the relative overlap of the two projected pictures as part of a general study of problems in stereoscopic vision. The xerograph, to which reference has already been made, was shown to be a process of photographic image reproduction which depends on a simple application of electrostatics and a photoconduction mechanism in selenium. By this method it is possible to produce either a positive or a negative picture in about a minute, without the usual wet chemical processing. Two stands exhibited what is described as the flying-spot microscope. The object on the microscope stage is scanned by a blue-violet light from a cathode-ray tube and the transmitted light received on a sensitive multiplier photoelectric cell, the output of which is used to modulate a raster on a monitor tube. The latter showed a bright, very much magnified image of the microscopic object.

Permanent magnets in which the pole-pieces are sintered as an integral part of the magnet assembly of 'Alcomax' or 'Alnico' were exhibited, in forms suitable for moving-coil instruments, high-frequency generators, dynamo rotors, etc. By this sintering process it is now possible to obtain a low reluctance path across the junction of the permanent magnet and its soft iron poles. An interesting development in accumulators was shown in which silver (positive) and zinc (negative) form the active plates. Standard production sizes range from 0·5 to 40 amp.-hour capacity having weights ranging from $\frac{1}{2}$ oz. to 28 oz. The voltage of each cell is 1·5. A new application of the now familiar resistance strain-gauge was exhibited in the form of a submarine pressure meter, the out-of-balance of the bridge being used to indicate pressure, depth under the sea, weight, etc. Direct-writing electrocardiographs were demonstrated using a hot-wire stylus recording on thermo-sensitive paper. This form of recording is almost frictionless at the stylus point, and the hot wire makes a very clear black line as it burns off the ethyl cellulose coating of the recorder paper. An Admiralty research establishment demonstrated a comparator for magnetic materials of low permeability, based on a principle devised by Prof. A. O. Rankine, with a range of permeability of 1·00001–1·0003. This device could give direct indications of the permeability of materials such as distilled water or 'iron-free' copper. A quick-acting sensitive hygrometer is formed from an anodized aluminium wire coated with a thin layer of porous conducting material (for example, 'Aquadag'). The cylindrical condenser thus formed strongly absorbs water vapour (and other vapours), thereby increasing its dielectric constant. The instrument was demonstrated as an atmospheric humidity recorder, and as a detector of moisture in soils and at a number of points in a water-soaked piece of timber. A valuable aid to medical research, of a type mentioned by Prof. Mayneord in his discourse, was a scintillation counter demonstrated under conditions representing typical hospital use. It comprises an eleven-stage photo-multiplier tube, an interchangeable phosphor and a wide-band amplifier. A lead collimator mounted in front of the crystal is used to define the sensitive zone of the instrument. A contamination meter has been designed expressly for civil defence which will measure accurately the gamma-activity of fission products on clothing, etc., in terms of milli-röntgens per hour at a specified distance. The instrument can be used on a table allowing 'suspected' persons to file past the probe, or it can be carried around in a haversack, the probe (containing a Geiger counter) being brought near the suspected areas of contamination. Beta-ray thickness gauges, serving to measure or control the thickness of manufactured materials in the form of strip, foil or sheet, now appear to be in general use in numerous industries manufacturing paper, metal foil, lino, rubber, plastics, etc. A number of exhibits gave demonstrations of this useful device. The use of radioactive tracers in the study of furnace gas flow is now a possibility. By introducing a pulse of radon at the air intake, and scintillation counters to measure its concentration in gas samples taken at various points, valuable information on the furnace behaviour is obtained.

The exhibition of work by apprentices and learners was most impressive. The fine examples of glass-blowing, optical glass work and metal work left one with the feeling that there is plenty of young talent coming along which is quite capable of upholding the high standard of craftsmanship in the British scientific instrument industry. This year, the Silvanus P.

Thompson prize for the most meritorious performance was awarded to R. G. Munro (of the Marconi Wireless Telegraph Co.). Most of the entries were of a very high standard, and the selection of the prize-winner must have presented a very difficult problem for the judges.

As usual, an exhibitors' meeting was held during the exhibition to discuss possible improvements in the organization of future exhibitions. The Council and Exhibition Committee of the Physical Society are to be congratulated on yet another successful exhibition.

A. B. Wood

FUNCTION AND LOCATION OF ENZYMES IN CELLS

At a meeting of the Royal Society on March 12 the subject of "The Function and Location of Enzymes in Cells" was discussed by a number of workers from Great Britain and abroad.

Prof. J. Z. Young (Department of Anatomy, University College, London), in opening the discussion, emphasized that the essence of the problem is to develop methods of high resolution. Much can be done by centrifugation and other methods of separation, but in the end we shall have to depend upon microscopy. Full use of microscopic methods would involve improvement of means of measurement, and a step in this direction might be found in the development of the technique of the flying-spot microscope. He also directed attention to the need for adequate models with which to speak about the organization of processes within the cells, and suggested that perhaps the techniques of information theory might be helpful to biochemists in this respect.

Dr. H. Holter (Carlsberg Laboratory, Copenhagen) described his experiments with the large amœba *Chaos chaos* and discussed the possibility of separation of different phases within its cytoplasm by centrifugation of the living cell. As test enzymes for these investigations, he chose succinic dehydrogenase, dipeptidase and catheptic proteinase, the last an enzyme likely to be difficult to localize because it is especially sensitive to autolytic changes, of which it is itself a mediator.

After cutting centrifuged amœbæ into heavy and light portions, it was found that their dipeptidase content was equal, which means that it is not associated with any centrifugable cell constituent but occurs throughout the cell in the hyaloplasm. On the other hand, the proteinase and succinic dehydrogenase were clearly displaced towards the centrifugal pole and are presumably bound to the mitochondria.

Comparable results were obtained by the technique of centrifugal separation after homogenization, except that the proteinase is liberated by this process from the cell constituent to which it is usually attached. Dr. Holter emphasized that homogenization techniques must, however, always give rise to equivocal results because the hyaloplasm is insoluble in water unless autolysis occurs.

Prof. J. F. Danielli (Department of Zoology, King's College, London) discussed the difficulties involved in the identification of the sites of phosphatase action by cytochemical techniques. He showed that phosphatase is found at sites concerned with active transport, such as the brush border of the proximal convoluted tubules of the kidney, epithelial cells of the small intestine and silk-secreting glands. He went on to develop the thesis that the enzyme is concerned particularly with making energy available for contractile proteins. Thus considerable amounts of phosphatase are found along chromosomes and during new collagen formation. During discussion of this paper, some objections to this hypothesis were raised by Prof. C. D. Darlington and others, who were doubtful whether the association of phosphatases with, for example, nucleoli, could be regarded as evidence of their action upon contractile proteins.

The distribution of enzymic activities of the mitochondria of pea seedlings were then discussed by Dr. D. D. Davies (Department of Botany, University College, Hull), who presented strong evidence that the enzymes responsible for the Krebs cycle in plants are closely associated with the mitochondrial fraction. Each step of the Krebs cycle was demonstrated by chromatographic identification of products in partially inhibited systems.

Dr. S. J. Holt (Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London) described the development of new staining techniques for the intracellular localization of enzymes, beginning with the necessity of finding readily penetrating chromogenic substrates of low molecular weight, but yielding highly insoluble products. The oxidation of indoxyl to indigo has been found to meet most requirements for a chromogenic reaction. The reactions of various substrates derived from indoxyl have been investigated and several found which are very suitable for the revelation of esterases. The chief problems are to obtain a precipitate of negligible granularity and to prevent diffusion effects. Using substrates such as 5-homoindoxyl acetate and 5 : 7-dichloroindoxyl acetate in the presence of suitable oxidizing agents, it is possible to show fine details of the distribution of esterases in motor end-plates and, for example, in the cells of the kidney, liver and pancreas. Methods for phosphatases have also been developed, and extension to other enzymes is well advanced. During discussion of this paper, it was suggested that false localizations might be obtained, due to the activity of oxidizing enzymes producing an indigo at their site of action. Dr. Holt replied that this had been fully investigated and that the same localizations were found in the presence of high concentrations of oxidase inhibitors.

Dr. F. R. Johnson (Department of Anatomy, University of Sheffield) presented slides, prepared by the Gomori technique, of the distribution of alkaline phosphatase in the epithelial cells of the small intestine. He showed that the appearance of the deposit of cobalt sulphide depends on control of the last steps of the technique and is related to the strength and age of the ammonium sulphide solution used. Under suitable conditions, a bilaminar distribution of the enzyme is seen in this tissue and also in kidney proximal convoluted tubules. Prof. H. A. Krebs pointed out that this distribution corresponds to that expected from suggested biochemical mechanisms of transport; but Prof. Danielli was doubtful whether the bilaminar appearance could be regarded as truly reflecting the distribution of the enzyme in the living cell.

Experiments showing that dipeptidase activity is a property of polynucleotides were described by Prof. F. Binkley (Emory University School of Dentistry, Georgia), who has been able to isolate a non-protein fraction from pig kidney which hydrolyses dipeptides such as cysteinylglycine. This activity is not

destroyed or decreased by proteolytic enzymes, or in other procedures directed to remove all proteins, or by heating to 80° C., or concentration by evaporation on a water-bath. Further evidence for the absence of protein was obtained by the negative result of standard protein tests and by the fact that the material did not induce antibody formation. Ultraviolet absorption spectra were typical of nucleic acids, and chromatographic analysis showed good correlation with the properties of polynucleotides. Prof. Binkley emphasized that there is no evidence to suggest that any dipeptidase is a protein, and no real surprise should be caused by the discovery that they may be something other than protein. Electrophoretically homogeneous preparations could be prepared by extraction with aqueous acetone and autolysis at 50° C. Subsequent fractional precipitation with ethanol leaves the active component in the supernatant, and a crystalline product can be isolated of extremely high activity compared with that of proteolytic enzymes composed of protein. Some of the difficulties of this interpretation were mentioned, particularly that ribonuclease or snake venom does not destroy the enzyme activity, except at a low *p*H at which activity is rapidly lost even without added enzymes. However, these enzymes do combine in 1 : 1 proportions with the active material and inhibit it. A second difficulty is that commercial nucleic acids are not active as dipeptidases; but they may be made active by a purification procedure. Further experiments have shown that plant viruses have similar peptidase activities and that these are actually enhanced by digestion with proteolytic enzymes.

In the discussion of Prof. Binkley's paper, no convincing difficulties in his interpretation were raised. Prof. J. D. Bernal emphasized the extent to which our views on protein synthesis would be clarified if we could start with the presumption that nucleic acids were themselves proteolytic enzymes.

The localization of enzymes in muscle were discussed by Dr. S. V. Perry (School of Biochemistry, Cambridge), showing in particular that adenosine triphosphate cannot be free in the cell. The myofibrils probably contain bound adenosine triphosphate and the mitochondria an enzyme responsible for splitting it.

Prof. A. Claude (Laboratory of Cytology and Experimental Cancerology, University of Brussels) described his methods for separating cells into fractions of distinct particle size and enzymic activity. He showed that, even with small differences of density, sharp separation is possible by successive centrifugation, though this may be interfered with by agglutination. He compared quantitative determinations of the quantity of glycogen obtained by centrifugation and by chemical separation, and also clearly illustrated the value of this technique as a preparative method by showing gram samples of cell constituents isolated in a short working-time. Prof. Claude then surveyed the morphological features of cells and discussed the fine structure of mitochondria, as revealed by electron microscopy. In conclusion, he pointed out the need for developing more refined centrifugation techniques for the further separation of similar particles, such as mitochondria, into types with different enzymic activities.

Prof. H. A. Krebs (Department of Biochemistry, University of Sheffield) outlined experiments on the distribution of ions and inorganic substances in cells. He emphasized that an understanding of these distributions depends upon our treating the cell as not being in osmotic equilibrium, for the osmotic pressure in a cell may be two or three times that of the blood plasma. The conception that the cell is enveloped by a semi-permeable membrane is not complete because there are many intracellular boundaries; many substances may thus penetrate the cell and yet not gain access to all parts of it. Distribution of sodium ions is maintained by the mechanism of a 'sodium pump' actively removing the ion, and this may occur not only at the cell surface, but also at surfaces within the cell.

Experiments with slices of guinea pig brain and kidney cortex in which the potassium loss and sodium gain were studied were next described by Dr. R. E. Davies (Department of Biochemistry, University of Sheffield). Under proper conditions reversible interchanges can be recorded. The water content of the tissue depends more on its metabolic activity than on the composition of the medium. Thus the turnover number of sodium ions to oxygen consumed was very high (5,000 : 1), and it is necessary to postulate an energy-linking system between entry to and escape from the cell. Treatment with dinitrophenol unlinks the process of transport from its energy sources and allows accumulation of sodium within the cell. The whole of the sodium and potassium content of a cell was found to be able to exchange in a very short time. Dr. Davies then presented evidence that these activities are controlled by enzymes located in the mitochondria. Fractions consisting mainly of mitochondria are thus able to concentrate ions and pump out water.

In closing the discussion, Prof. Young thanked the contributors for the various original observations reported during the day; he directed attention to the fact that the only mention of a new model was Prof. Krebs's comparison of the cell with a leaky ship kept afloat by pumps.

SAMPLE TABLES FOR THE 1951 CENSUS OF GREAT BRITAIN

In the past, the General Register Office has often been severely criticized for its delay in the publication of the results of the decennial census of population. The critics often ignored the fact that the professional staff of the Office was very small, and that they had to cope with the routine work of the Office in addition to the census. It is therefore most creditable to the Office that a summary of the main results of the 1951 census came into the hands of the public within nineteen months of the date of enumeration*.

This was only made possible by the decision—for the first time in the history of censuses in Great Britain—to make a preliminary analysis of a sample of 1 per cent of the census schedules. Sampling had an additional advantage—tabulations which would have been prohibitively expensive and complicated in a full census were quite feasible for a sample. A sample of census schedules is also likely to be more accurate than an *ad hoc* inquiry: the completion of the schedule is compulsory, and sample selection can therefore be strictly controlled. The problem of non-response is minimized, and there is probably

* General Register Office and General Registry Office Scotland. Census 1951, Great Britain: One Per Cent Sample Tables. Pp. 367. (London: H.M.S.O., 1952.) Part 1, 17*s*. 6*d*.; Part 2, £2.

more goodwill among the general public towards the census. The sample itself will be so large that sampling error will be negligible, and it is therefore to be hoped that the sampling procedure will be continued in the future. Although the sampling error is negligible, it is unfortunate that it is not discussed at greater length in the introductory pages. Those responsible for the publication of the report surely owe a duty to the public to explain their working methods fully, rather than treat them as esoteric mysteries. This is a small point; but there has recently been a general tendency on the part of those at the Office to explain their working methods in such general terms that it is not possible to follow their work in detail, so that criticism is made unduly difficult. (For example, the number of 'schedules' drawn in the sample as distinct from the number of 'persons' is nowhere given.) A second innovation must be gratefully mentioned. For the first time for a hundred years, the results for Great Britain are given in a single volume. It is to be hoped that the co-operation between the two registrars-general of England and Wales and of Scotland will continue, and that the national tables of the full census will also be given for Great Britain as a whole, as well as for the two constituent countries. It has been one of the minor irritations of persons working on British population figures to have to work with two different fat volumes, and occasionally to discover irritating minor differences in the definition of terms.

The sample tables in the two parts are numbered consecutively, so that the report may be regarded as a single whole. It is divided into different sections, and it would be invidious as well as presuming to try to deal with the results and their significance in a short article. I shall therefore content myself with describing the tabulations, indicating the innovations and commenting on some of the methods.

One of the main functions of the census is to give detailed statistics for local areas. In a 1 per cent sample the details must necessarily be less extensive than in a full enumeration, and the local tabulations are confined to the counties and larger towns. There is one welcome innovation, however: the provision of separate tables for the seven large conurbations centred on London, Birmingham, Manchester, Liverpool, Leeds, Newcastle and Glasgow.

Ages, Marital Condition, Occupations and Industries. These subjects are, of course, the main concern of the census-taker. The treatment follows conventional lines, but there are some minor innovations. The occupations are divided into thirteen 'socio-economic groups' in addition to the conventional five so-called 'social classes'. Any attempt at social classification which is based on occupations only must of necessity be rough, and can at best only approximate to what the sociologist understands by 'social class'; but given these limitations, a division into thirteen groups will, of course, be much more useful than one which makes use of five groups only, particularly when housing and fertility differentials are studied.

From the tables it is possible to obtain information about the structure of the population by sex, age, marital status, occupation and industry, and about some of these factors in combination. One can study the age structure of the labour force, the number of women in different industries, the extent of the employment of married women, and similar topics.

Housing and Structure of Private Households. The census defines a private household as a "single person living alone or a group of individuals voluntarily living together under a single menage in the sense of sharing the same living room or eating at the same table; boarders and domestic servants are included in the household with which they are enumerated as also are visitors when such are present. But a lodger or group of lodgers having or sharing separate accommodation to themselves should have been enumerated on separate schedules and are thus treated as separate private households, distinct from the main occupying household of the dwelling, whether or not they rely on the latter for incidental service in the matter of room cleaning, food preparation, etc.".

It will be seen that the definition of a private household is necessarily a little vague, and that ambiguities are bound to arise. In the case of lodgers there is an almost infinite gradation between the boarder who lives *en famille*, on one hand, and the lodger who merely rents a room to sleep in and has no dealings with the rest of the household, on the other; and in marginal cases it is difficult to ensure uniform treatment. Moreover, there is the problem of visitors. It is not very easy administratively to allocate visitors who are away from their homes back to the area of their usual residence. It seems likely *a priori* that members of small households are more likely to be mobile than those from larger ones, so that errors do not necessarily cancel out. It is also evident that the term 'private household' is not synonymous with the term 'family'. This confusion has been partly caused by the use of the latter word in previous censuses.

The tables show the total number of households by size and by number of rooms occupied, distinguishing in general those households which have to share a dwelling. Crowding indices can be calculated from these data. It should, however, be borne in mind that the number of rooms in the dwelling is obtained by the enumerator in the course of a hurried visit. Though substantial inaccuracies are unlikely, these figures are probably of a lower reliability than the rest of the census data.

The foregoing remarks also apply to a new feature. In 1951 enumerators were instructed to inquire whether the household had the exclusive use of piped water, cooking stove, kitchen sink, water closet and fixed bath, or whether any or all of these amenities were shared with another household. The tabulated answers make it possible to compare housing conditions in different parts of the country.

The second volume begins with tables showing information on household structure. The households are classified by the number of earners and the number of children that they contain; but it is the section next following which is of particular interest. Here an attempt is made to study in greater detail the structure and composition of private households, and, for this purpose, visitors have been excluded. Households are divided into those containing 'primary family units' only—that is, consisting merely of the head of the household, his or her spouse, children, ancestors and unmarried sibs of the head, and resident domestic servants. Such households form 86 per cent of the total contained in the sample. In the remaining 'composite' households, the members not belonging to a primary family unit have been further analysed into 'family nuclei' consisting of married couples or lone parents with their children. Composite households containing such nuclei were regarded as less stable than other composite households, as it was believed that they would in most

cases desire separate accommodation of their own. Their number and distribution would give one index of the amount of involuntary 'doubling-up' that exists. It was found that roughly a half of all composite households contained family nuclei, the large majority of these consisting of married children of the head or his spouse.

This tabulation will not be repeated for the full census. It is therefore regrettable that the data are only broken down by geographical region and that no attempt has been made to obtain information regarding household structure by occupation or social class. Such information has not previously been available, and its publication might throw some light on the nature of the housing problem which we are facing.

Education. One of the new questions included in the census related to the age at which full-time educational instruction had ceased. For some incomprehensible reason, the question was confined to males and occupied females, so that no information is available about the education of housewives (whom the census authorities still regard as 'unoccupied'). Moreover, the figures are particularly difficult to interpret at present, as the education of many persons was interrupted by the Second World War and continued after demobilization, so that the proportion whose education ends comparatively late may well be abnormally high. More valuable results may be obtained at the next census, when the question should, however, be re-phrased, as the age at which education ends is only one of the factors influencing what might loosely be described as 'education status'.

Fertility of Marriage. In the present census questions relating to the fertility of marriage have been asked for the first time since 1911. All married women under the age of fifty were required to state the date of their present marriage, the total number of children born alive to them, and whether they had given birth to a live child in the year preceding the census. The information is tabulated in a special section of sixty pages, and the tables are well set out. The limitation of the questions to women under the age of fifty is, however, utterly incomprehensible and most deplorable. It means that no comparisons can be made with the fertility experience of older women who bore the greater part of their children in the early nineteen-twenties. It is true that the sample census of the Royal Commission on Population taken in 1946 will remedy some of the deficiency, but it is by no means certain that the material will be comparable.

Information is made available about the distribution of married women by marriage duration, age, age at marriage and total number of children. The figures for social class and socio-economic group are analysed, and the women who bore a child in the year preceding the census are separately distinguished. It is thus possible to obtain data on differential fertility without having to marry vital registration and census statistics, in which occupational and other definitions may sometimes differ, thus causing minor incomparabilities.

Minor Tabulations. Among other information presented there is a table dealing with non-private households, information regarding birthplace and nationality, and statistics on the Welsh- and Gaelic-speaking population.

Enough has been said to indicate the wealth of material available in the new publication. No full census has been taken in Britain since 1931, and the information is therefore all the more welcome. The sample tables will probably contain sufficient detail for most purposes. The full evaluation of the data will take time, but they promise to throw light on some social problems about which hitherto relatively little was known.

E. Grebenik

OBITUARIES

Sir Francis Knowles, Bart.

Sir Francis Howe Seymour Knowles, fifth baronet, who died at Oxford on April 4, at the age of sixty-seven, made notable contributions to two branches of the complex discipline of anthropology. Like many other anthropologists, he began his studies in a different field of knowledge, for he read law at Oriel College, Oxford. He then took the diploma in anthropology at the first examination held in Oxford (1908), and afterwards the degree of B.Sc. During 1909–12 he taught physical anthropology under Prof. Arthur Thomson, helping to place the subject on a firm scientific foundation. During that period he catalogued and measured two large collections of skulls; he also collaborated with Sir Arthur Keith in a study of teeth of palæolithic man from Jersey, and with Prof. W. J. Sollas in an examination of the Aurignacian skeleton from Paviland Cave, Gower.

He left Oxford to undertake field-work among the Iroquois in Ontario. In 1914 he was appointed physical anthropologist to the Canadian Government, a post which he held for five years. His work on the skeletal material from the Roebuck prehistoric village site, "The Physical Anthropology of the Roebuck Iroquois", was published by the National Museum of Canada. A severe attack of typhoid, contracted in the field, left his health permanently impaired, and brought his career as a physical anthropologist to a premature end.

Returning to Oxford, Knowles took up the study of a subject in which he had long been interested, namely, the techniques used by ancient and modern Stone Age peoples in the manufacture of their tools and weapons. Using only the materials and tools known to have been available to prehistoric man, he practised patiently until he had acquired a skill comparable to that of the best craftsmen of the past. In this way began his long association with the Pitt Rivers Museum, Oxford, where he studied, and added considerably to, the prehistoric collections, arranged exhibition cases showing the variety of techniques employed by stone-workers from ancient to modern times, and held practical classes whereby his pupils obtained an insight into the difficulties overcome by prehistoric man. One of his most important discoveries was described in "The Manufacture of a Flint Arrow-head by Quartzite Hammer-stone", published as the first of the Museum's "Occasional Papers on Technology". Shortly before his death, he completed "Stone-Worker's Progress" for the same series.

Knowles took nothing for granted, but taught and published only what he had learned and verified by personal observation and experiment, thus giving lasting value to his work. His scholarship, his enthusiasm for his subject, and the selfless devotion with which he applied himself even to the routine tasks inseparable from it, were greatly admired by his colleagues, who will long remember him with respect and affection.

B. M. Blackwood

Mr. W. M. Jones

THE death occurred on March 15 of W. M. Jones, director of the Oceanographic Observatory of the Department of Scientific and Industrial Research, New Zealand. Born in Papakura in 1893, he graduated in 1914 with honours in mathematics. He was the New Zealand Rhodes Scholar of that year and took honours in physics at Balliol, Oxford. He served in the First World War in the Royal Field Artillery and N.Z. Engineers, and, after a few more years at Oxford as demonstrator in the electricity laboratory, returned to New Zealand.

His early magnetic, seismological and other geophysical work in New Zealand foreshadowed many of the discoveries which are of greatest interest to-day, and did much to establish the usefulness of scientific exploration. In 1950 he was given the task of developing oceanographical research in New Zealand, and has done much to advance the systematic study of the waters which influence its life, climate and fisheries. Being mainly interested in the applications of mathematics and physics, he has done useful research on waves, the relation between waves and microseisms, and the electromagnetic effects of tidal streams.

Jones had a wide interest in science apart from his own subjects, and an extensive knowledge of New Zealand. He was a very amusing travelling companion and always found the most interesting people to talk to and the most interesting things to do. His great fund of anecdotes about his early geophysical exploration showed a wealth of good feeling and love for his country. In his younger days he was a representative player of hockey and tennis both in Auckland and in Great Britain.

Jones's work was well known in Britain and the United States, as well as in New Zealand, and he will be greatly missed. G. E. R. DEACON

NEWS and VIEWS

Royal Institution : Sir Lawrence Bragg, O.B.E., F.R.S.

AFTER the annual meeting of the members of the Royal Institution held on May 1, Lord Brabazon of Tara (president) announced that the managers had appointed Sir Lawrence Bragg to the office of Fullerian professor of chemistry, resident professor and director of the Institution's laboratories. He will take up the duties of the Fullerian professorship immediately and the laboratory and resident duties on January 1, 1954. Sir Lawrence has been Cavendish professor of experimental physics in the University of Cambridge since 1938. Previous to this he had been director of the National Physical Laboratory, and he had also been Langworthy professor of physics, University of Manchester. He brings great academic distinction to the Royal Institution, and is worthy to stand in the place of Humphry Davy, Faraday, and the many famous scientists who succeeded them. Sir Lawrence had a brilliant career as a student and Research Fellow at Trinity College, Cambridge. In 1915, at the early age of twenty-five, he was awarded a Nobel Prize for Physics for his work on X-rays and crystal structure with his father, the late Sir William Bragg, who is remembered with affection by all connected with the Royal Institution as not only one of the most distinguished holders of the offices his son now receives, but also one of the best loved. For his many contributions to physical science Sir Lawrence has been awarded the Hughes and Royal Medals of the Royal Society, and honorary degrees and distinctions from many universities and scientific societies at home and abroad. He will bring to the Royal Institution not only an unrivalled record of scientific achievement and experience, but also those personal attributes of friendship and sympathy so characteristic of his father.

Other Officers

THE following have been elected officers of the Royal Institution: *President:* Lord Brabazon of Tara; *Treasurer:* Dr. L. H. Lampitt; *Secretary:* Mr. S. Hobson; *Managers:* Mr. L. V. Chilton, Dr. A. Clow, Mr. E. R. Davies, Mr. F. P. Dunn, Dr. A. G. Gaydon, Dr. R. E. Gibbs, Mr. A. C. Hartley, Mrs. H. K. Hawkes, Mr. L. B. W. Jolley, Dr. L. A. Jordan, Dr. H. Lowery, Dr. A. C. Menzies, Dr. J. H. Schulman, Mr. P. H. Schwarzschild, Dr. S. Whitehead; *Visitors:* Mr. H. E. Baker, Mr. F. G. Brown, Dr. H. K. Cameron, Mr. A. D. R. Caroe, Mr. J. F. Coales, Dr. H. Heywood, Wing Commander G. e. Hughes, Dr. A. R. Kagan, Mr. M. M. Melinsky, Mr. E. B. Moss, Mr. F. Y. Poynton, the Hon. Philip Samuel, Mr. W. E. Schall, Dr. L. Simons, Dr. P. C. Spensley.

Fuel Technology at Sheffield : Prof. R. J. Sarjant, O.B.E.

THE University of Sheffield—and indeed the community at large—owes much to Prof. R. J. Sarjant, who retires from the chair of fuel technology at the end of the academic year. Educated at the Royal Masonic School, Bushey, he graduated in chemistry at the Royal College of Science, London, afterwards receiving postgraduate training there. In 1918 his appointment as fuel officer to the research department of Hadfields, Ltd., was the beginning of more than a quarter of a century's experience of steelworks problems, including those concerned with refractory materials and metallurgical engineering. With Sir Robert Hadfield he published a number of papers on the use of solid, liquid and gaseous fuels, gas producer practice, alloy steels for furnaces and chemical engineering; and in 1924 he gave the first course of lectures on furnace heating at the University of Sheffield, the following year publishing in a book the results of his pioneer work. In 1937 he was appointed a local director of Hadfields and head of its research department, relinquishing this position at the end of the Second World War on his appointment to the Sheffield chair; this chair had been vacant since R. V. Wheeler's death in 1938, and in returning to academic life after a successful industrial career Prof. Sarjant recognized the opportunity for wider service and the need for great expansion of university training in fuel technology. He has always been keenly interested in university education in applied science, and set about extending his department with characteristic enthusiasm. Shortly after his appointment, he visited American universities and research organizations, and two years later was invited to lecture in Spain. He has been associated with many research committees on fuel and allied problems and was awarded the O.B.E. for his services to the wartime Fuel Efficiency Committee of the Ministry of Fuel and Power. Prof. Sarjant was a vice-president

of the Institute of Fuel during 1949–51 and in 1950 was awarded its highest honour, the Melchett Medal, choosing "Ignipotence" as the subject of his address. In this address he described some of the researches in his department, where incidentally there is now a record number of postgraduate students; the researches include work on coal chemistry, the reactivity, properties and production of metallurgical coke, heat transfer, furnace design, smoke repression in metallurgical operations, and gasification of low-grade fuels.

Mr. M. W. Thring

Mr. M. W. Thring, who succeeds Prof. Sarjant, was educated at Malvern College and Trinity College, Cambridge, graduating with first-class honours in Part 1 of the Mathematical Tripos and in Part 2 of the Natural Sciences Tripos. In 1937 he joined the staff of the newly formed British Coal Utilization Research Association, becoming head of the Combustion Research Laboratory in 1944. Experimental and theoretical work on the velocities and temperature drop in producer gas mains led to the award of the Student Medal of the Institute of Fuel in 1938. Among his war-time studies were the design of portable gas producers and the development of the down-jet system of combustion in fuel beds; these investigations culminated in a major study of port designs in open-hearth furnaces, carried out in 1944 in collaboration with Dr. J. H. Chesters, of the United Steel Companies, Ltd., and in 1949 Mr. Thring was awarded the Sir Robert Hadfield Medal of the Iron and Steel Institute for studies on open-hearth furnaces. In 1946 he took up a new post as head of the Physics Department of the British Iron and Steel Research Association, later being appointed superintendent and, recently, assistant director of the Association. In 1949 he took part in the early discussions leading to the formation of the International Committee for Research on Luminous Flame Radiation, and two years later became general superintendent of its researches. Mr. Thring is the author of a book on "The Science of Flames and Furnaces" and of many papers on fuel subjects, and he has made valuable contributions to the theoretical understanding of radiation during combustion and of the mechanism of combustion in turbulent jet flames.

Atomic Energy Research in Britain

Replying to a question in the House of Commons on April 28, Sir Winston Churchill stated that the Government has set up a committee, consisting of Lord Waverley (chairman), Sir Wallace Akers and Sir John Woods, with the following terms of reference: "To devise a plan for transferring responsibility for atomic energy from the Ministry of Supply to a non-departmental organization and to work out the most suitable form for the new organization, due regard being paid to any constitutional and financial implications". He remarked that considerable strides have been made in the development of methods of using atomic energy for industrial purposes, and these aspects are now coming very much to the fore. A non-departmental organization is considered by the Government to be necessary to secure rapid and economical development, for both military and industrial purposes, and the committee has the task of visiting the various establishments concerned with the view of devising a form of organization to meet the very special needs of the case. Overall policy must remain firmly in the hands of the Government, and methods of financial control will have to be devised since in the foreseeable future the considerable cost will fall on public funds. The rights and interests of existing staff in atomic energy establishments will be fully respected. It will be recalled that in July 1951, Lord Cherwell, speaking in the House of Lords, asked for the transfer of atomic energy development to some such non-departmental agency.

Atomic Energy Establishments in Britain

On May 4, Mr. Duncan Sandys, Minister of Supply, gave some information in the House of Commons about the work of atomic energy establishments in Great Britain. He said that Harwell is responsible for fundamental research into nuclear physics and atomic energy, and provides basic scientific information to the other establishments. The radio-chemical centre at Amersham is an offshoot of Harwell. It deals with the preparation of radioactive substances such as radium, radon, and radioactive isotopes produced in the atomic piles, and these are used for medical, scientific and industrial purposes. The production of fissile material is directed from headquarters at Risley, near Warrington, where the design and planning offices are situated. A factory at Springfields, near Preston, produces pure uranium from uranium concentrates; another, at Windscale, in Cumberland, produces plutonium from uranium by means of atomic piles; and a third, at Capenhurst, in Cheshire, has a gaseous diffusion plant for separating uranium-235 from the more abundant isotope uranium-238, producing a fissile material which can be used as an alternative to plutonium. Research work on atomic weapons is carried on at Aldermaston, in Berkshire, and its out-stations at Woolwich and Fort Halstead.

Effects of Toxic Substances on Wild Life

A written reply by the Minister of Agriculture, Sir Thomas Dugdale, given in the House of Commons on May 4, stated that the working party considering precautionary measures in the agricultural use of toxic substances has been reconstituted under the chairmanship of Prof. S. Zuckerman and will now consider the effects of such substances on wild life in general. It will include representatives of the agricultural departments, the Agricultural Research Council, the Agricultural Improvement Council, the Nature Conservancy, the fisheries departments, and the Medical Research Council. Its terms of reference will be: "To investigate the possible risks to the natural flora and fauna of the countryside from the use in agriculture of toxic substances, including the possible harmful effects for agriculture and fisheries, and to make recommendations".

Exhibition in the Science Museum, London, of Historic Books on Machines

The second of a series of special exhibitions of historic books relative to science and technology was opened at the Science Museum, London, on May 1 and will remain on view to the public, free of charge, until August 30 (weekdays, 10 a.m.–6 p.m.; Sundays, 2.30–6 p.m.). The exhibition deals with machinery and traces the development of machines from classical times up to the period of the Industrial Revolution in the eighteenth century. Although some of the very early machines were exceedingly crude in appearance, they often embodied fundamental principles which were taken up in later times

when materials and methods of construction were more developed. The progress of machines increased during the Renaissance, and more interest in them was stimulated about 1440 when movable-type printing was invented; it was then possible for books to be produced more cheaply and in larger numbers. The knowledge spread from Alexandria, to Greece, Italy, France, Germany and Britain, and by the seventeenth century there was much scientific activity, both theoretical and practical, which hastened their progress; with the development in Great Britain of the steam-engine during the eighteenth century, far-reaching economic and social changes occurred throughout Europe. The parts which great philosophers and pioneers, such as Heron of Alexandria, Archimedes, Cardan, Agricola, Gilbert, Galilei, Boyle, the Marquis of Worcester, von Guericke, Morland, Papin, Savery, Pascal and Faraday, played in the development of machinery is illustrated by many of the books. In general, the exhibition should appeal not only to those with a developed appreciation of machinery but also to all who, though they may have a slight knowledge of the subject, are interested in the materialistic progress of civilization.

Agricultural Census in Iraq

MANY important facts concerning agriculture in Iraq are being revealed for the first time by an agricultural and livestock census which was taken during the second half of 1952 under the direction of the government statistician, Dr. K. G. Fenelon, who was formerly director of statistics and intelligence at the British Ministry of Food. Every effort is being made to publish the data as rapidly as possible, and already reports are available for three out of the fourteen provinces (*liwas*) into which the country is divided for administrative purposes. These reports cover the Provinces of Baghdad, Basra and Amarah and show in considerable detail the great diversity of conditions under which farming is carried out in the country and the great variety of crops which can be grown. In Amarah Province, for example, the average size of the 483 farms in the area is 3,530 acres, there being a hundred farms of more than three thousand acres each, among which seven are more than thirty thousand acres each. In Baghdad Province, the 3,821 holdings average 240 acres, while in Basra the 18,013 farms average only 15 acres each, with some 11,000 farms less than 2½ acres in extent. The small size of farms in Basra is partially explained by the prevalence of date palm cultivation, which accounts for nearly one-third of the total area of the holdings. In Baghdad Province, there are more than three million fruit trees such as orange, apple, pomegranate, lemon and apricot, compared with two hundred thousand in Basra and thirty-five thousand in Amarah Provinces. The main field crops in the three Provinces are barley, wheat, rice and maize.

Considerable differences were found in the amount of labour engaged on the holdings. In Amarah there is one person for 25½ acres, in Baghdad one for 8 acres and in Basra Province one for 3½ acres. Livestock are somewhat more densely settled on the land, there being one head of livestock for every 3 acres in Amarah Province, 2·7 acres in Basra Province and 2 acres in Baghdad Province. In addition to the livestock on the farms, numerous other animals are maintained by 'stall feeding' or by pasturing on waste lands. In Baghdad Centre many cows, buffaloes and sheep are stall-fed, while in Basra Province many flocks were found pastured on waste lands, which varied in size from a few animals kept by individual families to immense herds of sheep, horses and camels owned by nomadic tribes, some of which roamed between Iraq, Kuwait and Saudi Arabia. Mechanical power is used on about eight hundred farms in the three provinces, but nearly all of these were situated in Baghdad Province. There are, however, eighteen thousand farms, mainly in Basra Province, which rely on human labour alone without any assistance from either animals or machines.

Archæological Excavations near Behshahr, Iran

THREE interesting articles on the excavations in the Hotu Cave, Iran, are contained in a recent issue of the *Proceedings of the American Philosophical Society* (96, No. 3; June 1952). The first of these, by C. S. Coon, deals with the site itself near Behshahr in the Caspian Sea region. Excavations were undertaken, and a brief account of them is given. Louis B. Dupree next describes the Pleistocene artefacts found. These consist both of bone and stone tools. There is plenty of material for study; but the industries contain few typical tools which can be linked up with finds made elsewhere. Further work at the site will be needed before any definite conclusions can be drawn. J. L. Angel in a third article describes the human skeletal remains from the Cave. Judging from the illustrations, the skull and jaw have been excellently preserved. Once again, it would seem that the skeletal remains do not fall into any well-known category. Obviously the excavators have discovered an interesting early occupation cave-site in an interesting region, and it is to be hoped that further explorations at Hotu and neighbouring sites will enable the authors to determine more accurately the age and relationships of the industries present.

Bulletin of the Italian Society of Geophysics and Meteorology

THE formation of the Italian Society of Geophysics and Meteorology in 1952 (see *Nature*, **170**, 144; 1952) has now been followed by the first number of the Society's *Bulletin* (*Bol. Soc. Ital. Geof. Met.*, **1**, No. 1; 1953. From the Society at Via Balbi 5, Genova; 3000 lire or 5 dollars a year). The contents of this first number include a paper on the exploration of the ionosphere over the Antarctic by an Argentine expedition, reviews of the present state of knowledge of cloud physics and artificial precipitation and of the relations between the electric field in the atmosphere and the humidity and quantity of pollution, a note on the causes of earthquakes, and reports of scientific conferences and news of recent researches on a world-wide scale. The cover carries a superb photograph of a waterspout off the Italian coast. It is not planned to publish large original papers by Italian geophysicists in this periodical. Such papers will continue to be published in *Geofisica pura e applicata*.

Press Guide to British Chemicals and their Manufacturers

THE Association of British Chemical Manufacturers has recently published a small book entitled "Press Guide to British Chemicals and their Manufacturers" (pp. 76; March 1953) and two thousand copies have been issued in the first instance to the national, provincial and technical press (including scientific

correspondents, editors of learned journals, etc.). The first twenty-two pages list the names and addresses of 126 chemical manufacturers, with the name and telephone number of an individual (often two names are given) who is authorized to supply information. A similar short section of two pages follows in which thirteen chemical trade associations are listed, dealing with special sections of the chemical and closely allied industries. The third section, consisting of seven pages, is an alphabetical list of chemical products, each one being indexed to at least one code number that represents the firm handling the product. Finally comes the fourth section, forty-five pages long, which contains a list of proprietary and trade names, and opposite each entry is the chemical name and the firm owning the copyright. Inquiries relating to this booklet should be addressed to the Association at 166 Piccadilly, London, W.1.

Announcements

Prof. F. J. M. Stratton, formerly professor of astrophysics and director of the Solar Physics Observatory in the University of Cambridge, has been elected president of the Society for Psychical Research in succession to Dr. Gilbert Murray.

The following appointments have been made in the University of London: Dr. C. B. Allsopp, reader in physics at Guy's Hospital Medical School, to the University chair of physics applied to medicine, tenable at the School; Dr. E. M. Crook, senior lecturer in the Department of Biochemistry at University College, London, to the University readership in biochemistry, tenable at the College.

The second British Instrument Industries' Exhibition will be held in the National Hall, Olympia, London, during June 30–July 11. The Exhibition will cover all spheres of instrumentation in industry, medicine, research and education. The organizers of the Exhibition are F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2.

The North-Western Branch of the Institution of Electronics will be holding its eighth annual exhibition of electronic devices at the College of Technology, Sackville Street, Manchester, during July 15 (12–10 p.m.), July 16–17 (10 a.m.–10 p.m.), July 18 (10 a.m.–7 p.m.), July 20 (10 a.m.–10 p.m.) and July 21 (10 a.m.–9 p.m.). In addition to the usual commercial section of the exhibition, there will be a scientific and industrial research section, incorporating exhibits from research associations and the universities. Copies of the exhibition catalogue (1*s.* 6*d.* post free) will be available early in July. Admission tickets (available after June 1) and further information can be obtained from the secretary, W. Birtwistle, 17 Blackwater Street, Rochdale, Lancs.

A conference on nuclear physics at intermediate energies will be held by the University of Pittsburgh during June 4–6, the provisional list of topics to be covered being beta-decay, nuclear reactions and scattering at intermediate energies, energy levels of light nuclei, and photo-induced reactions. Further information can be obtained from Dr. E. Gerjuoy, Department of Physics, University, Pittsburgh 13, Pa.

Last year, a meeting for Nobel prize-winners in chemistry was held at Lindau, Bavaria (see *Nature*, 169, 868; 1952), and was attended by nearly a thousand visitors. A similar meeting is being arranged this year, at which Nobel prize-winners in physics will be asked to give addresses; it will be held during June 29–July 2.

A postgraduate summer school in optical crystallographic methods, organized by the Department of Inorganic and Physical Chemistry of the University of Leeds in association with the Department of Adult Education and Extra-Mural Studies, will be held in the University during August 31–September 11. The course, which will be similar to those held in 1951 and 1952, will provide basic training in the theory and the practical use of the polarizing microscope for the study of crystals and other birefringent materials, and in the applications of the instrument in various branches of science and technology. The general aspects will be dealt with during the first week, and during the second students will specialize in their particular group; for example, chemical, mineralogical or biological. The fee for the course is 15 guineas. Residence is available at a cost of £10. Application forms (to be completed by May 11) and further information can be obtained from the Secretary, Department of Adult Education and Extra-Mural Studies, The University, Leeds 2.

The report on research at the Royal Technical College, Glasgow, during the session 1951–52 (pp. 36; 1952), gives a brief summary of research work in progress in the various departments, and to each account there is appended a list of the more important publications by members of the staff of the particular department during the year, with the titles of theses approved for higher degrees and particulars of reports prepared. The report replaces the former *Journal of the Royal Technical College*, publication of which has now ceased.

The Library of the United States Congress and Princeton University are sponsoring a conference on "Islamic Civilization and Culture", to be held in Princeton, N.J., during September 8–17, and in Washington, D.C., September 17–19. Thirty eminent Muslim scholars and intellectual leaders from countries of the Middle East and Asia have been invited to participate, and there will be a similar number of American delegates. The conference will be concerned with three aspects of the subject: classical elements in Islamic culture; Islamic law and society; and intellectual and spiritual movements in Islam to-day. Dr. Bayard Dodge, president emeritus of the American University, Beirut, Lebanon, is the executive director of the conference.

A list, under their current titles, of periodicals received in the Technical Library, Ratcliff Place, has been issued by the Birmingham Public Libraries (pp. 20; 1953). The list shows the Library's holding of each periodical, irrespective of any change of title, but does not include 1,250 periodicals and transactions of societies taken in the General Reference Library or the five hundred received at the Commercial and Patents Library. Periodicals with distinctive titles are entered alphabetically, neglecting the article, but other periodicals published by corporate bodies are entered under the names of the corporate bodies.

Erratum. In the list of awards of Commonwealth Fund Fellowships in *Nature* of May 2, p. 776, for "J. M. Williams" read "R. L. Williams".

SOCIAL POLICY AND THE SOCIAL SCIENCES

UNDER the broad, general title of "Social Policy and the Social Sciences", the recently formed British Sociological Association arranged its first conference, held during March 27–29 at Queen Elizabeth College, London. The opening address was given by Dr. Gunnar Myrdal, the executive secretary of the Economic Commission for Europe, who dealt with the relation between social theory and social policy. The whole of March 28 was devoted to group discussions, in which the conference was divided into three sections, meeting simultaneously; and on the following morning Prof. T. H. Marshall, after receiving verbal reports from the chairmen of the three groups, summed up on the work of the conference.

The first group began its discussions by considering what contribution social scientists could make to their main subject, namely, health. Dr. J. N. Morris, in introducing his paper on "Changing Needs", asked the pertinent question what, in our way of living, is leading to so much inefficiency and disease. Very little research, he said, is being carried out on the running of the health services, either to provide us with basic knowledge or even to enable us to judge how good the services are. More study is required if we are to know how far we are preserving freedom and the essential ideals of democracy. He suggested that social scientists might well collaborate with the medical profession in acquiring fundamental knowledge that would help us to deal effectively with such matters as smoke pollution, the defects of the catering industry, and the building industry. Many of these problems are social rather than medical; but teamwork is needed.

Prof. Ferguson Rodger, in a useful paper, took up the theme of changing needs from the angle of the psychiatric services. He showed how the scope of psychiatry has expanded rapidly from the concept of mere custody to a concerted and intelligent plan designed to care for the far greater numbers who are incapacitated by neurosis. In spite of this, half the hospital beds in Great Britain are devoted to major mental illness, and it is natural that we should still be hospital-minded and only half aware of the great advances in non-institutional psychiatric treatment. Prof. Rodger cited, for example, the therapeutic and economic value of hostels and day hospitals; the development of the latter means that twice as many patients can be treated in the same space, through the saving in beds and other night furniture.

As the discussion went on, it became clear that the emphasis was shifting from the consideration of medical needs as such to the *terra incognita* between medical and social science. Dr. M. I. Roemer, for example, asked how social science could help in the transfer of new ideas from one culture to another. This means that it should address itself to study of the best time for their absorption, as well as the rate at which new findings in medical care could be digested. Dr. J. H. F. Brotherston carried the discussion further by considering, in a thoughtful paper, how medical education could be helped to give the student a deeper knowledge of the springs of human behaviour. Much could be done, he felt, by showing the student the real practice of both medicine and social work in the homes of the people: "The medical student emerges from training with a well-developed scientific approach to disease processes. At the same time he may be as ignorant as the next man when it comes to understanding his patient as a person whose social situation is of the greatest importance in determining his reaction to ill-health. His scientific training may increase rather than diminish his difficulties in this direction".

In this way the issue of the practical contribution of social work to medical practice is revealed, and its value is generally agreed. A more fundamental question, however, was uncovered, so to speak, by Dr. Brotherston's plea for integration. What is social science, and how far can its practical applications be regarded as the core of the subject? Social science is concerned with human behaviour, but honour is not satisfied merely by its handing over a technique to medicine, even if it bears the pleonastic title of 'social medicine'. If social science and medicine are to work happily together, then each needs confidence in its own techniques, and there must be an agreed common basis of understanding. It may well be that the medical man needs the help of social science in therapy, in preventive action—such as the limitation of neurosis—and, above all, in framing policy through the study of priorities in medical care. The fundamentals of social science were again considered, by Prof. M. Ginsberg, in his closing commentary on the conference. While recognizing the great value of the conference in bringing together workers in so many different fields, he felt that the meeting as a whole suffered from the vagueness of its title, especially as it concealed a lack of real knowledge of the terms social science and social policy. He argued that a good deal of so-called social research is not research in any accepted sense of the term; much of it is plain common sense mixed with a little elementary physiology and psychology. There is a profound difference between fundamental and applied theory, and therefore the function of social science proper is to find out the principles themselves. Social psychology, for example, is in danger of being overwhelmed with new techniques, as in the study of public opinion. The theoretical side is not being investigated at all, as, for example, the theory of public suggestibility as a basis for propaganda. The study of the techniques of propaganda and public attitudes do not advance the theory at all. Similarly, in relation to values, Prof. Ginsberg pointed out the confusion between fundamental studies and the operational research which consists in trying to find out what people want. This is a relatively simple matter, he said; but when one begins to criticize what people want, that is where values come in.

The group dealing with health further considered the problem of co-ordination and integration of the tripartite services under legislation for the National Health Service in Great Britain. In many respects our lack of knowledge of how the Service works is a serious matter; and, as Prof. R. M. Titmuss pointed out in his paper, there is a great deal of confusion not only about the role of the social services but also about the theoretical framework within which these services can be appraised as an integral part of the total performance of the social system.

The papers belonging to the second section, "Design and Planning", ranged over a very wide field, from the broad implications of the Town and Country Planning Acts to the more intimate social problems of rehousing the family. Hitherto, the social scientists have been able to do little to influence such plans, but the fruits of their research have had considerable potential value and ought not to be neglected. To the observer of the discussions relating to these papers the day's work was stimulating; but sometimes there crept in a doubt about whether some of the more basic questions were being missed. There were so many different views on how the needs and aspirations of a planned community could be measured; it was therefore disturbing to feel that the experts had not reached any solid basis of agreement.

The third section of the conference—on "Needs and Standards in the Social Services"—began by considering social security in the epoch following the Beveridge Report. Recent years have brought about developments which were not foreseen when the scheme was planned. Ever-increasing demands are being made on the central exchequer to supplement the allowances paid under national insurance. These allowances fall substantially below the minimum subsistence requirements as assessed by the scale of need of the National Assistance Board. In 1952, 24 per cent of the households drawing retirement pensions were receiving supplementary assistance compared with 18 per cent four years previously, and the same trend is apparent in the other branches of national insurance. Clearly it would be impossible to raise the level of contributions to make the scheme actuarially sound. Would it therefore be better to drop the figment of a contributory insurance and finance the entire scheme out of general taxation? Or should one follow some other British Commonwealth countries and raise the money through a progressive social-security tax? In such a case should there be progressive rates of benefits, thus taking account of the fact that different people have different needs? Would it be advisable to develop some branches of social security as self-supporting insurance schemes—for example, those providing for short-term crises such as sickness or unemployment—while financing the remainder out of general taxation? These were some of the questions raised in the discussion. There was a general feeling that the abandonment of the principle of a contributory insurance for the purpose of economy and simplification in administration would, in the popular mind, entail the abandonment of the right to benefit. This right is held dear by working people, particularly in regard to unemployment. The imposition of a test of need would be considered as harking back to the days of the means test and the Poor Law. There is some recent evidence to show that there is still reluctance to claim assistance on the part of unemployed workers. Old people, too, it has been said, like to feel that they have something which they have earned, contributed or 'put by' for themselves and generally deplore the idea of charity.

It seems desirable that the purpose of the various social-security schemes be thought out and defined more clearly with the view of bringing about modifications designed to meet the needs for which they were intended.

The group turned to subsistence standards and to methods of measurement in social science. A method of measuring poverty that takes into account the actual purchasing behaviour of people was discussed and shows promise of an improvement over its precursors. Then followed a discussion on the advantages and limitations of social survey techniques. It was agreed that such investigations could provide accurate factual data on the problem of needs and standards in the field of social insurance, but there was a lively debate on their value to the administrator in policy-making and in assessing priorities in the field of social welfare. Here the question of values which had obtruded itself many times in the conference came to the fore. Social scientists cannot claim the right to pronounce on how value judgments are to be made, but—and perhaps this was a keynote of the meeting—they can provide factual data by which such judgments can be considered and made more rationally.

INSECTICIDES AND COLONIAL AGRICULTURAL DEVELOPMENT

SOME eighty representatives of Colonial agricultural administration, of applied entomology, and of insecticide research and development were invited to Bristol by the Colston Research Society during March 23–27 to take part in a symposium dealing with insecticides in relation to Colonial agricultural development. The conference, which had the support of the Colonial Office and the Agricultural Research Council, was directed by Prof. T. Wallace, head of the Bristol University Agricultural and Horticultural Research Station at Long Ashton.

In the opening session, Dr. W. G. Hall (Commonwealth Institute of Entomology) stated that entomologists have been appointed in only fourteen of the thirty-eight British Colonies. The Colonial Empire, totalling 2¼ million square miles, with a population of 70 millions and an annual export of crops valued at £182 million, employs, in all, 29 entomologists. Dr. Hall referred to the coming expiry of the Colonial Welfare and Development Act in 1956 and expressed the hope that ample funds will be made available to continue the pest-control work initiated by that Act.

Mr. C. B. Symes, of the Colonial Office, outlined the insecticide research programmes in the British Colonies, emphasizing the uses of the chlorinated hydrocarbons on pests of food plants. He pressed for an increase in fundamental work on specific Colonial problems.

Mr. S. Callaway, of the Chemical Defence Experimental Establishment, Porton, gave a detailed account of an air-spraying operation against locusts in Tanganyika, in which a spray of 20 per cent dinitrocresol in oil destroyed 4½ million locusts (96 per cent of the original population).

In the discussion on these papers, several speakers questioned the practicability of introducing insecticide treatments on peasant-grown crops. Sir Harold Tempany pointed out that the yields from peasant holdings are exceptionally low and will have to be increased because population is outpacing food production. Mr. W. T. Cowan noted that co-operative societies of native cotton growers are starting in Uganda.

In the afternoon session of March 24, Mr. E. O. Pearson (Empire Cotton-Growing Corporation) said that the control of jassid on irrigated cotton in the Sudan is the only instance in Africa of large-scale insecticide applications to this crop. He considers

that the employment of insecticides on peasant cotton awaits a more orderly system of farming and an increase in basic yields by improved cultivation and manuring.

Mr. R. S. McKinlay (East African Agriculture and Forestry Research Association) described a method of assaying *Lygus* damage to cotton by using weekly spraying of individual rows with DDT and toxaphene to provide pest-free plants for comparison of yields with those of surrounding *Lygus*-infested rows. He suggested that the inevitable delay in extending insecticide treatments to peasant crops might give time for the perfection of effective techniques.

In the discussion, Mr. Pearson recorded that the United States yields, being ten times those of Africa, carry a much higher cost of spraying. Mr. Leyland Cole deprecated the use of over-crude methods for applying the potent modern insecticides. A question on developments in the Congo elicited the reply that a much greater degree of direct control of agriculture is established there than in British colonies. Mr. McKinlay believes that the peasant cultivator can be taught to use insecticides but that it will be a slow process.

On the second day, Mr. G. Swaine (Department of Agriculture, Tanganyika) recorded experiments showing that treatment of cotton with five applications of 10 per cent DDT plus 3 per cent BHC greatly increases yield by controlling American bollworm. On coffee, the Pentatomid bug *Antestia lineaticollis* is now widely controlled in East Africa by DDT emulsion. Contact insecticides have given striking results when applied as seed dressings or mixed with soil; for example, BHC against termites or sugar-cane white grubs, aldrin and BHC against the wheat pest, *Heteronychus consimilis*, and toxaphene against cutworms.

Mr. M. J. Way (Rothamsted Experimental Station) described certain ecological balances between pests and predators that might be adversely affected by insecticides. In Zanzibar the *Theraptus* bug attacking coconut palms is often kept in check by a predatory ant. This ant, however, encourages the mealy bug suspected of being the vector of a virus attacking clove trees. A similar relationship between ants and mealy bugs exists on cacao in West Africa.

Mr. J. Bowden (Agricultural Department, Gold Coast) described the damage done by insects to the African's principal food crops– maize, sorghum and millet.

During the discussion it was stated that seed dressing with BHC uses only one-tenth of the quantity of material employed in broadcast applications, but still gives a residual effect. The phytotoxicity of BHC to tobacco seedlings was noted.

In the afternoon, a paper by Mr. R. G. Fennah (Imperial College of Tropical Agriculture) was read by Mr. D. B. Murray. Mr. Fennah considers that, in the West Indies, losses due to the inefficiency of agricultural methods far outweigh those caused by insects. The successes so far gained by insecticides in that area are the suppression of the sugar-cane froghopper in Trinidad and the simplification of parasol ant control.

Prof. J. W. Munro (Imperial College, London) warned the conference that transfers of native labour from subsistence agriculture to industry will bring famine nearer, unless satisfactory storage and transport of foodstuffs can be provided. Much existing knowledge of stored-products pest control is not being used. Prof. Munro emphasized the importance of training selected Africans and West Indians as technicians in the practice of storage pest destruction.

In the discussion, Dr. Jepson said he hopes that the development of agriculture as a subject of study in African universities will be encouraged by the provision of sufficiently attractive posts for Africans trained in agricultural science. He described the methyl bromide fumigation of the groundnut 'pyramids' at Kano as an outstanding example of co-operative effort. Mr. Swaine explained the method of pit storage in Tanganyika, which depends on the production by hermetically sealed grain of sufficient carbon dioxide to act as a fumigant. Dr. R. C. Fisher directed attention to infestations of timber, and outlined the activities of the West African timber-borer research team appointed by the Colonial Office to study infestation in logs before export.

The first paper of the morning session of the last day of the Conference was a general review by Sir Thomas Dalling (Food and Agriculture Organization, Rome) of the insect-transmitted diseases of livestock in Colonial territories. This was followed by a film and paper by Dr. J. Carmichael (formerly of the Uganda Veterinary Department) describing tsetse control in Zululand by application of DDT aerosols from Anson aircraft. Seven such applications in the period September 1950 to January 1951 reduced tsetse populations by 97–99·9 per cent.

Mr. H. E. Harbour (Cooper Technical Bureau) referred first to the earlier treatment of ticks on livestock by sodium arsenite dips, and the development of arsenic-tolerant tick populations. At present, BHC, DDT and toxaphene are making great contributions to tick control. In two areas in Tanganyika tanks have been installed and compulsory dipping instituted. As substitutes for dipping tanks, spray 'tunnels' are proving effective.

The discussion was opened by Dr. J. C. Matthysse (Cornell University), who has been working on ticks in Rhodesia under the auspices of the Mutual Security Agency. He described systems of pen spraying of cattle, using itinerant spray teams. Dr. J. T. Martin suggested that the cost of derris treatment against warble flies might be lowered by the use of synergists. Mr. Symes described the contribution of the workers at Porton in the design of pumps and nozzles for tsetse-eradicating sprays.

In the final session, Dr. H. G. H. Kearns (Long Ashton Research Station) stressed the fact that the successful solution of a spraying problem must take into account the biology of the pest, the spray material, the culture of the crop, the machinery and the user. Present designs, particularly of small manual sprayers, are capable of much improvement, but low-priced standardized designs necessitate large orders. 'Air-flow' mist sprayers can be used for drift spraying only in exceptional cases, as in locust control. Appreciation by the engineer of the biologist's problems is fundamental to the development of satisfactory equipment.

Dr. E. Holmes (Plant Protection, Ltd.) summarized the magnitude and cost of the search for, and development of, new insecticides. He emphasized the necessity for the overseas user to give the manufacturer ample time to ship materials to ensure their delivery at a given date. He referred to the benefits that are accruing from the closer co-operation between official research workers and those from industry.

In the discussion, Mr. Higgins mentioned that the training of entomologists at the Imperial College, London, includes instruction in the use of spray

machinery. Mr. Hoare stressed the importance of obtaining exact data on spray deposition and offered the use of an electronic deposit analyser. Mr. Joyce described low-volume spraying in the Sudan, using 25 per cent DDT concentrate at just over ¼ gallon per acre. Mr. Symes considers that until formulations of insecticides and designs of machinery are based on much more fundamental research there will be much guesswork in pest-control procedures.

Throughout the conference the outstanding value of co-operation between home and overseas workers was apparent, and it was made clear that one of the immediate problems in Colonial agriculture is the reconciling of peasant cultivation with the need to increase food production by modern methods of pest control.

R. W. Marsh

NATIONAL RESEARCH DEVELOPMENT CORPORATION

REPORT FOR THE YEAR 1951–52

Sir Henry Tizard's cautious reference to the National Research Development Corporation in his Messel Memorial Lecture last July would of itself induce careful scrutiny of the third report of the Corporation, covering the year ended June 30, 1952, which has now been published*. Although in content and arrangement this report differs somewhat from the two previous reports, which were concerned largely with describing the administrative arrangements, internal and external, and the policy it was proposed to pursue, and describes in more detail the kind of work now being done, it still appears that the Corporation has been in operation for too short a period for a sound judgment as to whether the fear is justified that the existence of such a government body will of itself discourage the spirit of adventure on the part of industry. The brief factual account of its work contained in this report gives no indication of any such trend, if indeed such a trend is likely to be reflected in the work of the Corporation itself.

Some 1,736 patents and patent applications have been vested in the Corporation during its first three years, and, of the 1,027 of which the Corporation was first apprised during 1951–52, 491 were from government departments and research councils, sixteen from British Commonwealth official organizations, one from a nationalized industry, eight from industrial research associations, fifty-three from universities, three from charitable organizations and 455 from private firms and individuals. Many of these last-named, of which 432 were British, were not of public importance. Of patent rights in inventions assigned to the Corporation during the year, 414 were from government departments and research councils, three from industrial research associations and twenty-two from universities, out of a total of 445; and of 401 United Kingdom patent applications and 559 United Kingdom granted patents that were held by the Corporation at June 30, 1952, 235 of which were the subject of 776 overseas patents and patent applications, 844 came from government departments and research councils, seven from industrial research associations and eighty-seven from universities. Most of the 199 licence agreements entered into at June 30, 1952, were not yet revenue-carrying, and net receipts from the various assets were £25,676.

During the year details of 361 inventions were the subject of 8,871 circulations to industrial firms and led to 245 inquiries. Of these, and of a further hundred inquiries brought forward from the previous year, 166 eventually proved abortive and 101 were still under consideration at June 30: the balance resulted in licence negotiations, of which thirty-one had been completed and forty-seven were still proceeding at that date. A second group of inventions includes some two hundred government and research council inventions, represented by patents and patent applications assigned to the Corporation, about eighty from universities, and a few from research associations and private inventors. All these cases are somewhat complex, requiring more-or-less constant individual attention. Sometimes the subject-matter is still too immature or tentative or the field of possible application as yet too remote or obscure to call for any action at this stage, but, from this whole group of inventions, nine licence agreements were concluded and thirty-two were still the subject of licensing and development discussions.

From the third group of inventions, of a long-term character, for which no individual enterprise can be found that is prepared to spend money on development, and in which the Corporation has undertaken the financial responsibility for development, some fifteen development projects have been sponsored during the Corporation's first three years, and further details of some of these are given in the report. Electronic digital computers have been the subject of ninety-nine inventions assigned to the Corporation, fifty-nine being from universities, thirty from government departments and corporations and ten from industrial firms. Patents have been applied for in respect of seventy-four of these inventions in ten foreign countries, and the Corporation has given a contract for the supply of four machines similar to that installed according to the design of Prof. F. C. Williams at the University of Manchester, where grants for development have also been made by the Corporation. The Corporation is, too, entering into a further contract for the supply of a prototype of a machine of much-reduced size based upon the development of special techniques which are expected to decrease cost and increase reliability.

The Corporation is assisting with grants of money for staff and materials experimental work at the Imperial College of Science and Technology, London, on a project for hydrocarbon synthesis; and development work at the National Physical Laboratory, Teddington, arising out of Sir Thomas Merton's work on diffraction gratings, and particularly in relation to spectroscopes, is being assisted by the provision of staff. Two industrial firms in the instrument industry have already taken out licences under the patent rights assigned to the Corporation in respect of these inventions. The Corporation has also agreed to sponsor a project, emanating from Sir Harry Ricardo, for a light steam-engine, which is operated off boiler plant designed to be fired with low-grade fuel and which is based on the application to such engines of the considerable engineering processes made during recent decades in the field of light internal-combustion engines. The project is regarded as likely to contribute materially to Commonwealth interests by meeting the need for small prime movers in under-developed regions of the world. A pilot plant in East Africa, where sisal juice is available in quantity for

* National Research Development Corporation. Report and Statement of Accounts for the Year 1st July, 1951, to 30th June, 1952. Pp. 18. (London: H.M.S.O., 1953.) 9d. net.

the production of hecogenin, based on a laboratory unit set up under the joint auspices of the East African Industrial Research Board and the Medical Research Council, is being sponsored by the Corporation to provide a centre for more extended study of the methods of extraction and processing. In the field of scientific instruments, the Corporation has undertaken, jointly with an industrial firm, the development of a British photogrammetric plotting instrument from an invention of Prof. E. H. Thompson, professor of surveying in University College, London; and, in order to accelerate production, it has, with Board of Trade approval, undertaken a share of the financial risk involved in the development of an aural microscope and chick-sexer from the invention of Mr. C. S. Hallpike, of the Otological Research Unit of the Medical Research Council.

TESTING OF BEARING PROPERTIES OF METALS

ENGINEERS and metallurgists have long been faced with the problem of assessing the bearing properties of any particular bearing alloy. One obvious method (and perhaps the best) has been to test the materials under practical working conditions; but, although this may be effective, it is extremely costly and slow. For these reasons a number of simplified empirical methods have been devised which aim at providing a useful 'figure of merit'. In a paper on "Some Experiments with Sleeve Bearing Metals" (*Trans. Danish Acad. Tech. Sci.*, No. 2; 1952), Dr. Borge Lunn has described another test of this type. As he points out in his introduction, it has generally been recognized as a defect of existing hydrodynamic theory that it does not take into account the nature of the journal or bearing material. In practice, however, the behaviour of a bearing is very markedly dependent on the type of lubricant and bearing material used, and this, in turn, is associated with the frequency and extent to which the hydrodynamic film is penetrated. Dr. Lunn's test has therefore been primarily designed to give a measure of the breakdown and penetration of the lubricant film.

The experimental arrangement is a development of that described by Kauppi and Pedersen[1]. It consists of a hard steel ball which reciprocates over the surface of the bearing alloy at a frequency of about seventy strokes a minute, the load being of the order of several kilograms. The rubbing surfaces are insulated and the electrical resistance between them measured during the reciprocating motion. The method is similar to that described by Courtney-Pratt and Tudor[2] and by Popinga[3] in their investigation of the lubrication between the piston ring and cylinder wall of a running engine, and shows results of the same type. When the surfaces are instantaneously at rest the resistance is low, indicating some metallic contact or, at best, a regime of boundary lubrication. During the central part of the stroke the resistance fluctuates between high and low values as a fluid film is built up and then punctured. Further, as a result of a running-in effect, there is an overall increase in the resistance during the first few minutes of the test, a steady state being reached after several hundred strokes have taken place. Dr. Lunn's procedure is to determine the average resistance during the first 250 sec. of running by a current-potential method using a pen-recording voltmeter of relatively low frequency. The difference (expressed as a percentage) between the full potential drop obtained when the surfaces are completely separated by a fluid film and the average potential drop observed in any particular experiment is then taken as a measure of the breakdown of the lubricant film. The '*L*-values' so obtained are found to vary with the bearing alloy examined and with the lubricant used. Thus a good combination, implying little breakdown of the lubricant film, gives an *L*-value of 10–20 per cent, a poor combination 80 per cent and a bearing using a silicone oil as much as 95 per cent.

Dr. Lunn finds that with tin-base bearing alloys the *L*-values obtained are lower when the alloy is quickly solidified. The *L*-values are decreased when lead is introduced in place of copper and antimony and, to a smaller extent, in place of tin. With bronze alloys the presence of a phosphide eutectic produces a low *L*-value.

Ageing of the lubricant usually produces a reduction in the *L*-value implying improved lubricating properties, while the presence of an antioxidant gives poorer lubricating properties. As a result of these investigations, Dr. Lunn suggests that the effectiveness of a bearing-lubricant combination depends on the formation of a suitable surface film as a result of chemical reaction between the rubbing metals, the lubricant and the surrounding atmosphere. In addition, Dr. Lunn claims that his *L*-value provides a single 'figure of merit' which agrees well with practical performance. It would be interesting to see this extended to other materials and to see if the order of performance is significantly changed by simple alterations in the experimental conditions. D. TABOR

[1] Kauppi, T. A., and Pedersen, W. W., *Nat. Petr. News*, **37**, 944 (1945).
[2] Courtney-Pratt, J. S., and Tudor, G. K., *J. Inst. Mech. Eng.*, **155**, 293 (1946); see also Tudor, G. K., *J. Coun. Sci. Indust. Res. (Australia)*, **21** (3), 202 (1949).
[3] Popinga, R., *Automobiltech. Z.*, **44**, 247 and 272 (1941).

NOISE FROM AIRCRAFT AT SUPERSONIC SPEED

REFERRING to recent correspondence on this topic in *Nature*, Dr. E. Esclangon has directed attention to two communications by him published in the *Comptes rendus* of the Paris Academy of Sciences. The first, published on November 17, is "Sur les détonations balistiques, engendrées par les projectiles et les avions supersoniques", and the second, published on November 24, 1952, is "Sur les sifflements de projectiles et bruits d'avions en vitesse supersonique". Dr. Esclangon's views on the acoustic effects of supersonic aircraft are based on his extensive work on the shock waves of projectiles during the First World War, published in 1925 in "L'Acoustique des Canons et des Projectiles" (Paris: Gauthier-Villars, 55 Quai des Grands Augustins, Paris 6e).

Dr. Esclangon points out that aircraft do not differ essentially from projectiles in the production of shock waves, except that they carry very noisy contrivances which add to the disturbance resulting from their movement alone. The distinction is emphasized between (1) the continuous and uniform disturbance due to the pushing aside of the air, and (2) the periodic disturbances due to the rear turbulence and precessional movements of the projectile and to the roar of the jets of the aircraft.

For the uniformly evolved disturbance, the arrival at a distant observer's position P of disturbances set up over an element of the trajectory will be simultaneous and in correct phase to produce considerable amplification, and the resulting bang will be all the greater as the size of the moving body is increased. The 'ballistic wave' (to use Dr. Esclangon's term) is a closed surface for a body the velocity of which is increasing through the velocity of sound, consisting of two sheets, a forward one of conical form and a rear one more nearly spherical, the two merging tangentially. More than two 'ballistic detonations' may be perceived, depending on the shape of the trajectory.

In his second communication, Dr. Esclangon considers the periodic disturbances. He points out that these are generated in an element of the trajectory in the period of the disturbance which will arrive at P simultaneously; but in all phases corresponding to the period and which, added algebraically, will destroy the periodicity. If the mean pressure is not zero, it will add to the ballistic wave. Dr. Esclangon gives details of a critical experiment. An observer was placed near the point of impact of a large inert projectile fired from a gun at a distance of 54 sound-seconds. The speed of the projectile was, at all points of the trajectory, greater than that of sound, and the duration of its flight was 37 sec. It was expected that after the ballistic wave had arrived the whistling of the projectile would be heard in reverse for 17 sec.; but in fact nothing at all was heard. Dr. Esclangon finds difficulty in explaining this, although the experiment would appear to emphasize the fact that the bang is predominantly due to the ballistic wave and that the whistling from the remote beginning of the trajectory is too feeble to be heard.

After pointing out the possibility of further study through the medium of supersonic aircraft, Dr. Esclangon concludes with a forecast that, as the ballistic wave appears when the speed of the aircraft resolved in the direction of the observer equals the speed of sound, a flight path in the form of an equiangular spiral, centre P, would make P a sort of focus for a particularly powerful 'acoustic detonation'.

MARINE BIOLOGY RESEARCH IN GREAT BRITAIN

FIFTEEN papers on the species and habits of marine animals, the chemical constituents of sea water and the utilization of these substances by living animals and plants, etc., make up the contents of the last (No. 3) number of Vol. 31 of the *Journal* issued by the Marine Biological Association of the United Kingdom.

Dr. D. P. Wilson has continued his experiments on the settlement of *Ophelia bicornis*. Earlier work had shown that there is a range in the size of particles suitable to larval metamorphosis; but Dr. Wilson has now discovered that an organic film on the sand particles of suitable size renders them attractive to the larvæ, whereas sterilized sand of similar particle-size is repellent, with a neutral category between these two extremes. D. B. Carlisle records three species of *Tridemnum*. J. A. Allen has made an exhaustive study of more than two thousand five hundred specimens of *Nucula turgida* and *N. moorei*, and shows that they grade into one another, representing, in fact, a single species, *N. turgida*. Prof. N. Millott, while on a visit to Plymouth from Jamaica, investigated the skin pigment of *Holothuria forskali* and found that the cœlomic amœbocytes produce melanin for the skin pigment and that this production is coupled with the presence of an active phenolase system. G. Hoyle has studied spontaneous squirting in the ascidian *Phallusia mammillata*. Rhythmical patterns of activity in sedentary animals occur also in *Metridium* (Batham and Pantin, 1950) and *Arenicola* (Wells, 1949). This activity, which is inherent, is modified by external stimulation, but is not initiated from without. The inherent activity may be myogenic, "with considerable neurogenic control". Spontaneous squirting of certain ascidians is an integral part of their feeding mechanism, and clears out waste from both the pharyngeal and atrial cavities. Dr. D. T. Gauld and Prof. J. Raymont contribute a paper on respiration in the copepods *Temora*, *Acartia* and *Centropages*, in which they point out that estimation of the food requirements of copepod populations based on the respiratory-rate, as used by other workers, is unreliable unless the size distribution of the copepods making up the population is known. Moreover, at least in *Centropages*, different generations of the same species may, for unknown reasons, have different respiratory-rates, and temperature is therefore not the sole cause of variation. Dr. Gauld has also studied the grazing of copepods, chiefly *Calanus finmarchicus*, and has found that some fed continuously during a twenty-four hour period near the surface, not migrating downwards, while others underwent vertical migration and fed only at night near the surface. There is thus no general feeding rhythm, as postulated by certain workers.

Dr. W. R. G. Atkins and Miss P. G. Jenkins have examined monthly for a year the phytoplankton from a station ten miles south-west of the Eddystone Rock, between the surface and fifty metres depth. For the surface the maximum was in March, the minimum in June, with a moderate rise in September and a winter minimum in November. The botanical composition of the water was studied after culture in diffuse light in the laboratory, twenty species of diatoms, eight members of the Chlorophyceæ, and one each of the Chrysophyceæ, Dinophyceæ and Cryptophyceæ being recorded. Mr. R. F. Hutton describes a new furcocercous *Cercaria*, *C. reesi*, from the digestive gland of *Hiatella arctica* and *H. striata*. Dr. J. S. Alexandrowicz has continued his investigations on the nervous system of marine arthropods by observations on the nerves of the pericardial organs of the decapod Crustacea. He finds evidence that these organs, bathed directly by blood from the gills, produce substances influencing the heart rhythm.

Dr. H. W. Harvey has two papers on the utilization of chemical substances in sea water by *Nitzschia closterium*. This diatom can absorb organic phosphorus when inorganic phosphorus in solution has been exhausted, both in light and in darkness. Nitrogen-deficient cells can also synthesize organic nitrogen in darkness from ammonium, nitrate and nitrite, with intensity decreasing in that order, and also chlorophyll and yellow pigments. Dr. W. R. G. Atkins has resumed his work on the phosphate and silicate content of sea water, and compares the data with those for the 1923–25 period. He also reports on the seasonal variation in the copper content of sea water; this builds up in the winter and drops from May onwards, with a minimum in October.

Tests with materials for the preservation of fishing nets, by Dr. Atkins and Mr. F. J. Warren, showed that on cotton netting 'Cuprinol', or Dr. Olie's method with cutch and ammoniacal copper sulphate, worked well, the latter being the cheaper of the two, while on trawl twines 'Cuprinol' (British Columbia grade) was best. Work on the preservation of ropes is proceeding. This number of the *Journal* concludes with abstracts of memoirs recording work done at the Plymouth Laboratory and published elsewhere.

N. B. EALES

ARTIFICIAL STIMULATION OF RAIN AT KONGWA

DURING January–April 1952, cloud-seeding experiments for the artificial stimulation of rain were carried out at Kongwa, Tanganyika, in connexion with the growing of groundnuts and other crops there by the Overseas Food Corporation. The director of the East African Meteorological Department, Mr. D. A. Davies, has already described the methods used (see *Nature*, **169**, 1001; 1952), and now the results of the experiments have been published in the Department's "Memoirs"* and they prove to be very surprising.

The full details of the methods need not be given in this article, but, briefly, the seeding agents were released in a three-day cycle: silver iodide was released on the first day at a height of 14,000–15,000 ft., and hygroscopic particles (sea salt) at about 5,000 ft. on the second day. On the third day there was no seeding. Balloons carried canisters containing the seeding agent, which was released by exploding a small gunpowder charge by a time-fuse after a time of flight to bring the balloons to the desired height. The balloons were released downwind at a distance measured each day to ensure scattering of the particles over the same point at the centre of the farm area. Silver iodide is effective only at temperatures below − 5° C. and so had to be released at a much greater height than the hygroscopic particles which were released in the lower part of the cumulus clouds. Rainfall was measured by a network of gauges distributed over the roughly rectangular area, 22 miles by 7 miles in size, occupied by the farm area. The long side of the rectangle lay from east to west. The wind was easterly for nearly all the 114 days of the experiments. There is a ridge of high land running from north to south in the centre, and rainfall is normally appreciably greater there than in the eastern and western ends of the area.

The results are presented in isohyetal maps showing rainfall on all the days of each type of seeding and no seeding, with comparison with normal. There is no description of the rainfall of any individual day. The overall results are briefly as follows. (*a*) On days of seeding in both ways, the rainfall in the central area over which the particles were released was reduced from a total of 9 in. on days of no seeding to one of 3–4 in. for the days of each type of seeding; seeding thus appears to have produced a great decrease of rainfall over the central area. (*b*) On days of releasing hygroscopic particles, the rainfall in an area 6–12 miles downwind was above that on days of no seeding by up to 6 in.; rainfall over an area 5 miles upwind was also increased by 2–3 in. (*c*) On days of releasing silver iodide particles, rainfall upwind from the point of release was increased by at some places more than 6 in.; downwind there was a small decrease. (*d*) On some occasions, clouds in which hygroscopic particles had been released were seen to disperse rapidly.

The memoir explains the increase of rainfall 6–12 miles downwind on days of seeding with hygroscopic particles by the delay in formation of large drops. No reason for result (*c*) is suggested in the memoir, and there is no mention of a reversal of wind with height to carry the silver iodide particles to the east and so stimulate precipitation there.

On thirteen days when particles should have been released, it was already raining and balloons were not released because the fuses would have been extinguished. These days have been counted in the statistics as though seeding actually took place. As the memoir says, this makes the rainfall deficit in the central area even more surprising.

* East African Meteorological Department. Memoirs, Vol. 2, No. 10: Reports on Experiments at Kongwa on Artificial Control of Rainfall, January–April 1952. By D. A. Davies, D. Hepburn and H. Sansom. Pp. 14 + 8 pl. (Nairobi: East African High Commission, 1952.) 4*s*.

FORMATION OF GALL STONES: PHYSICAL PROPERTIES OF BILE SALTS

By A. J. H. RAINS and N. CRAWFORD

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STONE formation in the various secretory or excretory ducts of the human body is one of the problems being studied in this Surgical Unit. The gall stone is the particular type of stone selected for study, especially that which, as a rule, primarily arises in the gall bladder—the pure cholesterol and the mixed gall stone, as opposed to the pigment or metabolic stone which arises in the hepatic ducts.

Pure cholesterol stones, single or multiple, are uncommon, for usually bile pigments, among other compounds, are included in varying amounts, either diffusely or by way of lamination, so that mixed stones are the rule. Because pure cholesterol stones exist with varying amounts of pigment, it is likely that the latter is an inclusion and that the prime disturbance involves the cholesterol. This is the 'crystallization out' of cholesterol; but the chemical reaction which starts this off, or the character of the nucleus around which the cholesterol stone forms, is unknown, even though Wilkie[1] noted that granular calculi of calcium and cholesterin were formed in the infected bile of an experimental animal. Gall stones have not been produced, at least convincingly, by any other means.

Two important contributory factors (or pieces of circumstantial evidence) in the formation of these gall stones are hypercholesterolæmia and infection; but to these a third factor should be added, namely, the power of the gall bladder to concentrate bile.

Associated with cholesterol are the salts of the bile acids, in the solutions of which the sterol is dissolved, and it was therefore considered that any chemical study of the factors responsible for the formation of gall stone must commence with the exploration of the cholesterol – bile acid relationship, first with the physico-chemical properties of the salts of the bile acids.

The inference that the molecules of bile salts should exhibit physico-chemical characteristics similar to those of the paraffin-chain salts may be drawn from the fact that in structure they contain water-attracting and water-indifferent parts—they are 'amphipathic'. Like the paraffin-chain salts, they have foaming, detergent and emulsifying properties, consequent upon their power to reduce surface tension.

McBain[2] put forward the micelle theory in order to explain the abnormal curves produced by plotting equivalent conductivity or the depression of freezing point against varying concentration of certain colloids (paraffin-chain salts) in solution. With the increase in concentration, a critical point is reached when an abrupt change in the slope of the curve or a discontinuity may be considered to be due to a change of phase; in fact, ionic aggregation or micelle formation, as McBain called it, begins and extends over a certain range.

In Hartley's[3] contribution to the fuller understanding of the phenomenon, attention was directed to the fact that the salts of nucleic acid and possibly bile acids might undergo micelle formation at appropriate concentrations, though no experimental work on the latter had been done at that time.

Some particular observations of bile acid salts have been made since Hartley's paper; Bashour and Baumann[4], Roepke and Mason[5], and Johnston and McBain[6] conducted experiments in order to study the equivalent conductivity and depression of the freezing point at varying concentrations of different salts. The results showed that although there was no sharp change in the slope of the equivalent conductivity – concentration curves, the osmotic coefficient – concentration curves, as measured by the depression of freezing point or the vapour pressure, did in fact indicate ionic aggregation. McBain considers that the measurement of equivalent conductivity alone may not give direct evidence of the formation of ionic micelles. The bile salts studied were sodium cholate, deoxycholate, glycocholate and glycodeoxycholate at temperatures of 20° C.[4], 25° C.[5] and 0° C.[6]. The temperature of a solution known to show evidence of ionic aggregation is important, for it will affect the critical concentration at which the micelles begin to form and the range over which they continue to do so. As the bile salts occur naturally in the animal world, their propensity for micellar forms were studied by us at 37–38° C., that is, at the normal environmental temperature of man.

The bile salts examined are among those commonly present in human bile: sodium cholate, deoxycholate, glycocholate and taurocholate, and the properties studied were equivalent conductivity, osmotic pressure, surface tension, turbidity and viscosity in order to detect any evidence of change of phase.

Methods. The bile salts were obtained from Ward, Blenkinsop and Co., Ltd., together with a statement of their purity. All the determinations with the exception of freezing point were performed without removal from the water-bath, which was thermostatically controlled at 37° ± 0·5° C. by a Kodak 250-W. heater and a Sunvic *T.S.I.* bimetal thermostat with relay.

Conductivity measurements were made with a Mullard conductivity bridge, Type *E7566* (range 0·1–100,000 micro-mhos). The conductivity cell was the dip-cell Type *E7591* supplied with the instrument and had a cell constant of 0·79. The water used for making up the solutions had a conductivity of 3×10^{-6} mhos, thus limiting reliable measurements to concentrations greater than $M/320$.

The osmotic coefficient g was calculated from the relation

$$g = \frac{\Delta t}{(2 \times 1{\cdot}858 \times m)},$$

where Δt is the depression of freezing point in degrees and m is the molarity, g thus being the ratio of the value of the observed lowering of freezing point to that which would be expected for an 'ideal' fully dissociated electrolyte. Δt was measured with the conventional type of Beckmann freezing apparatus.

Relative surface tension values were determined by a stalagmometric method employing a Steiner pattern stalagmometer. In spite of ensuring that a drop number of 15 per min. was not exceeded, it was realized that this method could not give reliable values of relative surface tension, though interesting and significant results were obtained by a simple comparison of drop numbers. For maintenance of temperature during surface tension experiments, the stalagmometer was fitted into an air jacket and the whole unit submerged in the water-bath to below the level of the top graduation of the stalagmometer.

Relative viscosity readings were made with a Steiner pattern No. 1 viscometer inserted into a water-bath well above the highest graduation.

Photographs were taken of the bile salt solutions at times when changes in turbidity became apparent. In most cases this occurred within a day or two of making up the solutions, and microscopic examinations were carried out to eliminate the possibility of interfering fungoid contamination.

Results. Graphs of conductivity and the effect on surface tension were constructed for each particular bile salt. For the sake of brevity, a composite graph of a simple and a conjugated salt is shown (Fig. 1). The curves for the other bile salts studied showed similar characteristics. The range of concentration commences at $M/5$ and decreases to $M/1{,}280$. Sufficient quantities of the bile salts were not obtained to enable concentrations higher than $M/5$ to be studied and, due to possible limitations in sensitivity of the apparatus and the methods employed, figures for concentration less than $M/320$ were not plotted, although results were obtained. The surface tension values are expressed simply as drop numbers and are plotted as such.

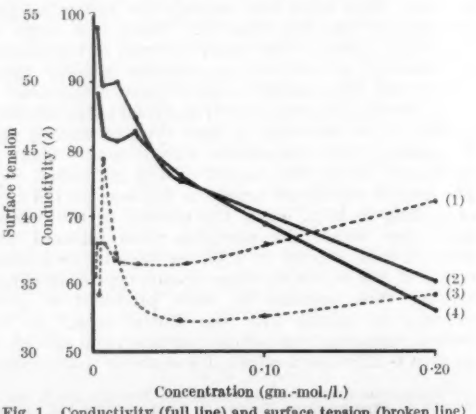

Fig. 1. Conductivity (full line) and surface tension (broken line) at 37° C. of: (1) and (4) sodium deoxycholate; and (2) and (3) sodium glycocholate

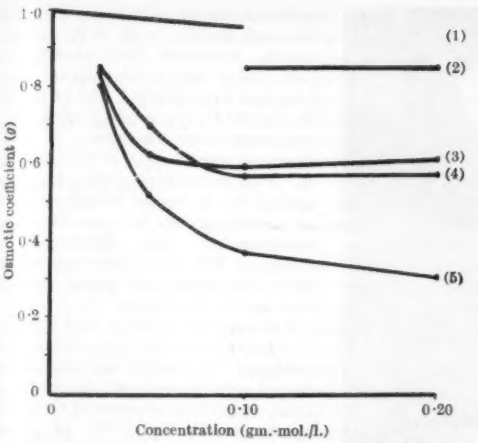

Fig. 2. Osmotic coefficients of: (1) potassium chloride; (2) sodium taurocholate; (3) sodium glycocholate; (4) sodium cholate; (5) sodium deoxycholate

It was not found possible to determine freezing point depressions at a concentration lower than $M/40$; in particular this was the case with sodium taurocholate—even at $M/20$. These curves are shown together (Fig. 2). In addition, the conductivity and osmotic coefficient values were compared as percentage decreases over the range $M/40$–$M/10$. It was found that although the osmotic coefficient for deoxycholate and glycocholate decreased by 54 and 30 per cent, the conductivity decreased by only 17 and 4 per cent, respectively. This may be of importance in assessing relative tendency to micelle formation by the bile salts, for Hartley, with paraffin-chain salts, and Roepke and Mason, with sodium cholate and glycodeoxycholate, believed such large differences of these properties to indicate appreciable association of bile acid ions.

Observations were made on the turbidity of the solutions 48 hr. after making them up, and photographs were taken under normal studio lighting conditions. Sodium deoxycholate and glycocholate produced markedly turbid solutions between concentrations of $M/1{,}280$ and $M/160$; from $M/80$ to $M/5$ they were crystal clear. Taurocholate showed the change at $M/40$, though not so abruptly. Sodium cholate solution showed no turbidity at any concentration.

Values for viscosity were obtained, but the limitations of a simple viscometer in such a study, with the difficulty of resolving the values into absolute viscosity, showed that the results could be of no assistance, and they are therefore omitted.

Discussion. The equivalent conductivity curves show a change of phase at about $M/160$; at about this point a 'kick' is shown on the graph; this may be due to the commencement of aggregation[5]. The curves are more convincing than those obtained by Roepke and Mason, or Johnston and McBain. The point of change of phase fits in with the point of maximal effect on surface tension, the point at which the abnormal depression of freezing point occurs, and also with the change-over from the turbid to clear state in three of the solutions.

In salts where visual changes were most apparent, namely, sodium deoxycholate and sodium glycocholate, greater differences in the percentage decrease of equivalent conductivity and osmotic coefficient over the range $M/40$–$M/10$ are shown than with sodium cholate, a salt in which no significant visual change occurred, and therefore these two salts perhaps have a greater tendency to micelle formation.

Conclusion. The bile salts, sodium cholate, deoxycholate, glycocholate and taurocholate, in solutions of increasing concentration undergo a change of phase which is demonstrated most readily by the equivalent conductivity, osmotic coefficient and surface tension curves, and which is taken to indicate ionic aggregation or micelle formation. Our turbidity findings may well be confirmatory evidence of this. The phenomenon is shown to advantage at 37° C. The range of the concentration of solutions in which these experiments were carried out is likely to occur in the human bile. Further work on the affinity of the bile salt micelle for cholesterol is to be published.

Grateful acknowledgment is made to the Medical Research Endowment Fund of the Birmingham United Hospitals, from which a grant in aid of this work was given. Thanks are also due to Profs. H. J. Melville, F. A. R. Stammers and Melville Arnott for their advice and assistance.

[1] Wilkie, A. L., *Brit. J. Surg.*, **15**, 450 (1928).
[2] McBain, J. W., *Trans. Farad. Soc.*, **9**, 99 (1913).
[3] Hartley, G. S., "Actualités Scientifiques et Industrielles", 387 (Hermann et Cie., Paris, 1936).
[4] Bashour, J. T., and Baumann, L., *J. Biol. Chem.*, **121**, 1 (1937).
[5] Roepke, R. R., and Mason, H. L., *J. Biol. Chem.*, **133**, 103 (1940).
[6] Johnston, S. A., and McBain, J. W., *Proc. Roy. Soc.*, A, **181**, 119 (1942).

A HIGH-RESOLUTION AERIAL FOR RADIO ASTRONOMY

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IN observations at radio wave-lengths, it is impossible to obtain an angular resolution which is comparable with that of even a small telescope. Even a relatively large object like the sun, which has been studied intensively by radio astronomers, is difficult to resolve at radio wave-lengths. It is known that solar radiation, at radio-frequencies, consists of several components, one steady over a period of months or years, and the others variable. The steady component has been identified[1] with thermal radiation from the 'quiet' or undisturbed sun. A determination of the distribution of brightness over the solar disk of this component would provide information about densities and temperatures in the atmosphere of the sun.

A 'slowly-varying component'[2] of the solar radiation which is prominent at decimetre wave-lengths can be correlated with the area of visible sunspots on the solar disk. Although it is known that this radiation originates in small 'bright' regions near sunspots[3], the shape and position in the solar atmosphere of these regions and their rates of growth and decay are not known.

Until now, most information about the distribution of radio brightness over the solar disk has come from eclipse observations. Such observations, however, have the serious drawback that they can be made only infrequently, and it is not possible to separate with certainty the various components of the solar radiation. The problem requires frequent observations with very highly directional radio equipment.

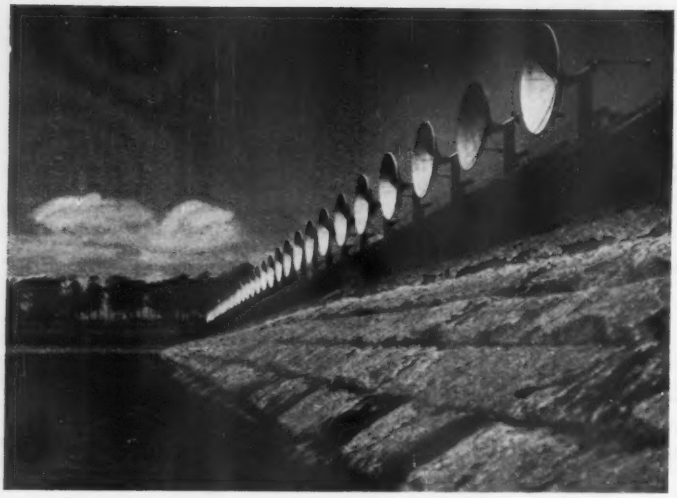

Fig. 1. 32-aerial interferometer at Potts Hill, Sydney

The size of an aerial required to achieve an angular resolution which is small with respect to the sun, say one-tenth of the visual diameter of the disk, is about 1,000 wave-lengths. At a wave-length of 2 decimetres, this corresponds to a diameter of about 700 ft. A rotatable antenna of such dimensions, and with the required constancy of shape, is not practicable.

If the resolution is to be provided in only one angular co-ordinate, the problem is greatly simplified, as the aerial has to be large in only one dimension. The aerial need not then be steered, because the beam is fan-shaped and the system may be arranged so that the rotation of the earth sweeps the beam across the sun. A two-aerial interferometer is a system of this type, but in its normal form is not useful for scanning a complex source like the sun.

A spaced-aerial interferometer with variable spacing between the aerials was used by Stanier[4] in an attempt to measure the distribution of the background component of the radiation at a wave-length of 60 cm. His method requires the solar disk to be free from any localized areas of enhanced brightness, and the background component to be symmetrical with respect to the centre of the disk. It is not clear from the published description how well the first of these conditions was fulfilled during the course of the work.

An aerial system which provides the required angular resolution in one dimension for scanning the sun has been constructed near Sydney. It produces multiple beams, but, unlike the case of a spaced-aerial interferometer with two elements, these beams have an angular spacing large enough to ensure that only one beam can scan the sun at one time. The system consists of thirty-two paraboloidal aerials, each 6 ft. in diameter, mounted individually on polar axes and arranged at equal intervals in a straight line of length about 700 ft. lying in an approximately east–west direction; it operates at a wave-length of 21 cm. (Fig. 1). The individual aerials are connected to a radio receiver by a branching system of open, two-wire transmission lines, arranged as shown in Fig. 2, so that the length of line between each aerial and the receiver is the same.

The system operates in a manner analogous to that of a diffraction grating. A family of knife-edge beams is produced, each beam being 3′ in width and separated from adjacent beams by 1·7°, or about three times the angle subtended by the diameter (visual) of the sun. The rotation of the earth causes each aerial beam in succession to sweep across the disk of the sun. A recording milliammeter at the output of the receiver indicates continuously the magnitude of the radiation being received from the strip of the solar disk to which the aerial beam is directed. The resultant trace is of the type shown in Fig. 3, in which the effect of several successive scans of the sun are seen. The records for each day's observations are averaged to reduce errors produced by random fluctuations in the receiver output.

A feature of the records is the appearance of peaks on the curves, indicating the presence of localized areas of enhanced brightness on the solar disk. As shown in Fig. 4, the positions of these bright areas change from day to day, which suggests that they rotate with the sun. The position of an aerial beam with respect to the solar disk at any time may be calculated from astronomical data and the geometry of the aerial system. From the time at which a peak appears in the output record of the receiver, one can deduce that the corresponding bright area on the sun is located along a certain line on the solar disk. The position of this line can then be compared with the positions of any optical features on the disk. Such a comparison is shown in Fig. 5, where lines indicating the positions of five distinct bright areas

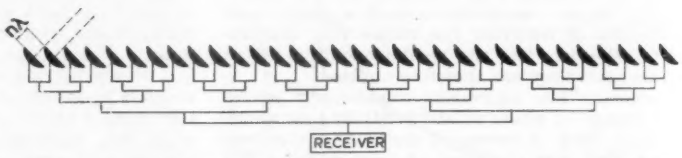

Fig. 2. Arrangement of aerials and feeder lines. The aerial response shows a maximum when the optical path difference for adjacent aerials is an integral number of wave-lengths

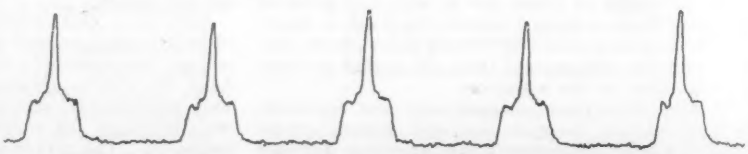

Fig. 3. Record of the sun passing in succession through several beams of the aerial

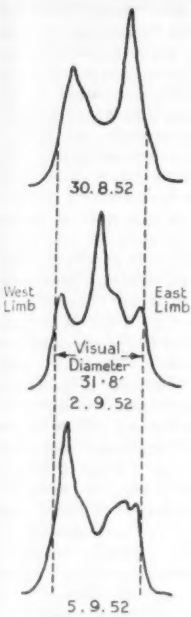

Fig. 4. Records obtained at intervals of several days. The change in position of bright areas is seen

are shown to fall close to sunspot groups.

If it is assumed that the bright areas have no independent movement with respect to the solar photosphere, then a series of daily records of position of any such area can be used for a determination of the heliographic latitude and longitude of the region and also the height of the region above the photosphere. Results to date indicate that the bright regions lie above sunspot groups or close to places previously occupied by sunspots.

The day-to-day variations in the brightness of such a region may be expected to show the combined effects of non-uniformity in angular distribution of emission from the region and of changes in actual emission with time. A statistical study of this should allow the two factors to be separated.

The one-dimensional brightness distribution of the background radiation, or radiation from the undisturbed sun, may be found directly if a record can be obtained during a period when the solar disk is free from areas of enhanced brightness. Alternatively, the distribution may be derived from a succession of

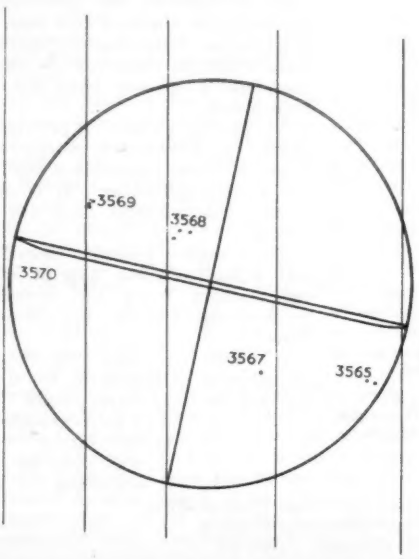

Fig. 5. The position on June 23, 1952, of five areas of enhanced brightness, indicated by lines on a sketch of the solar disk. The positions of sunspots are also shown

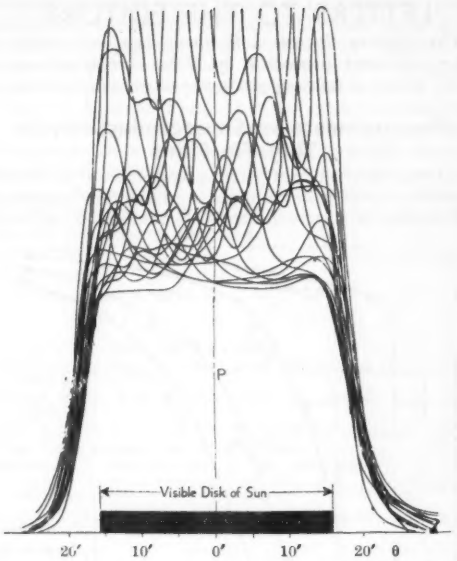

Fig. 6. Combined plot of a series of daily observations showing distinct lower boundary. *P* is the power received, in arbitrary units; θ is the angular separation between the centre of the aerial beam and the centre of the optical disk of the sun

daily records if a lower boundary curve is found below which the level never falls. In practice, it has been found that either method involves recording over a long period, even during the present period of low sunspot activity. A series of daily observations has been plotted in Fig. 6. The appearance of a relatively sharp lower boundary to the curves confirms the presence of a background radiation which is constant over a period of at least weeks. The shape of this boundary agrees with records obtained on two occasions when one half the solar disk was apparently free from areas of enhanced brightness. Preliminary results suggest that marked limb-brightening is present.

Two series of observations, one made during March and April and one during June and July 1952, have shown a small change in the brightness distribution near the limb. Non-circular symmetry of the source would be a possible cause of this, since in the interval the direction, relative to the sun's axis, in which the sun was scanned had changed considerably. This possibility is supported by eclipse observations[5] at a wave-length of 1·78 metres, which gave a brightness distribution that is not circularly symmetrical. A second aerial system arranged at right-angles to the existing system is being constructed to investigate this.

The observations are continuing and will be further reported in the *Australian Journal of Physics*. I wish to acknowledge the assistance of Mr. J. A. Warburton and Mr. A. J. Harragon in the work, and helpful discussion with Dr. J. L. Pawsey. [Nov. 28.

[1] Southworth, G. C., *J. Franklin Inst.*, **239**, 285 (1945). Pawsey, J. L., and Yabsley, D. E., *Aust. J. Sci. Res.*, **A2**, 98 (1949).
[2] Covington, A. E., *Proc. Inst. Radio Eng.*, **36**, 454 (1948). Lehany, F. J., and Yabsley, D. E., *Aust. J. Sci. Res.*, **A2**, 48 (1949).
[3] Covington, A. E., *Nature*, **159**, 405 (1947). Christiansen, W. N., Yabsley, D. E., and Mills, B. Y., *Nature*, **164**, 569 (1949).
[4] Stanier, H. M., *Nature*, **165**, 354 (1950).
[5] Denisse, J. F., Blum, E. J., and Steinberg, **J. L.**, *Nature*, **170**, 191 (1952).

LETTERS TO THE EDITORS

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Measurements on Superconductivity in Thin Tin Films

Continuing our previous measurements[1] on superconductivity of thin tin films, we have now measured the change in superconductivity, under the influence of a magnetic field and also under the combined action of the current and a magnetic field.

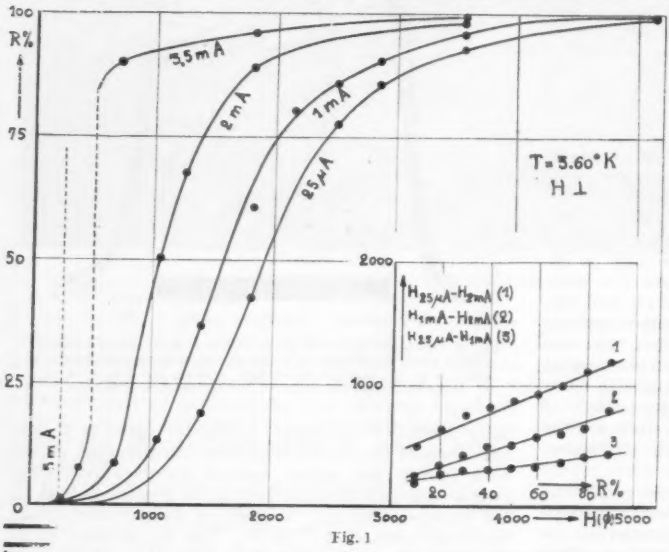

Fig. 1

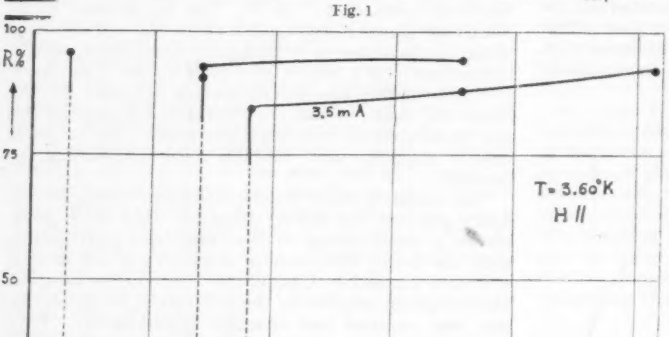

Fig. 2

Our deposits are obtained on small glass strips (length of the film, 5 mm.; width, 3 mm.) by sputtering in argon at room temperature using a cathode of spectrographically pure tin prepared by Johnson Matthey and Co., Ltd. In order to eliminate oxidation, the films are transported to the cryostat in an evacuated tube belonging to our special transport system. In the cryostat the film is dipped into the liquid helium. Hence it is possible to study the change in superconductivity even when using large current densities without the film being warm.

Just as in our previous measurements, we found that, for our films, the transition temperature is a few tenths of a degree higher than for normal tin. The behaviour of one of our films is described in this communication. The resistance of this film at room temperature is 116 ohms, at the boiling point of liquid oxygen it is 104 ohms, and at the boiling point of liquid helium 87·8 ohms. The transition temperature is 3·82° K., and after the transition there remains no residual resistance. This film, and also the others, showed a peculiar effect when we measured the disturbance under the influence of the combined action of an external magnetic field and the current. Figs. 1 and 2 illustrate the influence of a field, normal to the surface of the film and parallel to the film (in both cases perpendicular to the current) respectively, for different currents. The following points may be noted:

(1) By increasing the current, the transition curves become more and more sharp. Experiments of the same kind have been carried out by de Haas, Voogd and Jonker[2] on a monocrystalline tin wire, but they obtained flatter curves when the current was increased.

(2) The critical field for the direction parallel to the film is much larger than for the perpendicular direction. This fact has also been observed recently by Zavaritskii[3]. Moreover, we observed that even for large values of the current, the magnetic threshold value for the film is considerably greater than for the bulk metal.

(3) In Fig. 1 (inset) R per cent is plotted as a function of H_{i_1}—H_{i_2}, which is the compensating field for the current difference. It is noteworthy that straight lines are obtained.

The same general behaviour was found for this film at other temperatures below the transition temperature, and also for our other films.

We wish to thank the Belgian Department of Education for financial aid for these experiments.

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[1] Van Itterbeek, A., De Greve, L., and Van Gerven, L., *Med. Koninkl. Vl. Academie, Brussels* (in English), **14**, No. 5 (1952).
[2] de Haas, W. J., Voogd, J., and Jonker, J., *Physica*, **1**, 281 (1933).
[3] Zavaritskii, N. V., *Dokt. Akad. Nauk. S.S.S.R.*, **82**, 229 (1952).

Temperature of the Interior of the Earth

In a previous communication[1], I gave an outline of a new method for estimating temperatures in the earth's interior. The method was based on what I have called the temperature–pressure hypothesis, namely, that the reciprocal of the volume coefficient of thermal expansion α is a linear function of the pressure p:

$$\frac{1}{\alpha} = \frac{1}{\alpha_0} + bp. \qquad (1)$$

This relation was suggested by the analogous compressibility–pressure hypothesis of Bullen[2] and Ramsey[3], namely, that the reciprocal of the adiabatic compressibility is a linear function of the pressure.

Support for the temperature–pressure hypothesis was obtained using Uffen's[4] values of α, which were based on the theory of solids. An independent investigation based on Murnaghan's theory of finite strain has now been carried out, the results of which add further support to the temperature–pressure hypothesis. More important is the fact that the values of the coefficients $1/\alpha_0$ and b in equation (1), as obtained by these two methods, agree to within 10 per cent. Thus two independent lines of attack not only support the general hypothesis, but also agree among themselves as to the numerical value of the coefficients.

Birch[5], however, in his most recent paper on the constitution of the earth, disagrees with the compressibility–pressure hypothesis of Bullen and Ramsey, and regards the linear relationship between the reciprocal of the compressibility and the pressure as at best approximately valid over limited ranges of pressure for the particular materials of the earth's interior. It is not claimed that the temperature–pressure hypothesis is necessarily a fundamental physical relationship; but it is suggested that, in view of the agreement between two independent investigations, it should give a very fair approximation to the truth. Because of the lack of experimental data, which are both scanty and subject to relatively large uncertainties, the empirical relation (1) should be of considerable help in estimating temperatures within the earth.

The full implications of the temperature–pressure hypothesis are being investigated—in particular, the problem of the transfer of heat from the core. Assuming that the core has the composition of an iron meteorite, an estimate can be made of the conductive flow of heat in the core near the boundary of the core and mantle. Using the adiabatic temperature gradient based on the temperature–pressure hypothesis, a value of 5×10^{-7} cal./cm.^{2}sec. is obtained. On the other hand, using the melting point gradient and conductivity of olivine as obtained by Uffen[4], a value of $5{\cdot}5 \times 10^{-7}$ cal./cm.^{2} sec. is obtained for the conductive heat flow in the mantle near the boundary of the core and mantle. The difference between these two figures is not significant, being within the limit of their probable accuracy. It thus appears that sufficient heat can be removed from the core by conduction alone—a result hitherto not thought possible. This has far-reaching effects on Bullard's[6] dynamo theory of the origin of the earth's magnetic field, which requires a motion of the material of the core. It has been shown that thermal convection provides the only satisfactory mechanism for the generation of such motions. The results of the present investigation show that, in order to have convection in the core, it is not necessary to have convection in the mantle as well. This lends considerable weight to the contraction theory of orogenesis put forward by Wilson and Scheidegger[7] as against the convection current theory.

Finally, Bullard[8] found that the heat flow required to maintain convection currents in the core was about four times greater than that available from a core with a radioactive content comparable to that of iron meteorites. This discrepancy is almost entirely removed if figures based on the temperature–pressure hypothesis are used.

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[1] Jacobs, J. A., *Nature* [170, 838 (1952)].
[2] Bullen, K. E., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 5, 355 (1949); 6, 50 (1950).
[3] Ramsey, W. H., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 42 (1950).
[4] Uffen, R. J., Ph.D. thesis, Univ. of Western Ont., Canada.
[5] Birch, F., *J. Geophys. Res.*, 57, 227 (1952).
[6] Bullard, E. C., *Proc. Roy. Soc.*, A, 197, 433 (1949).
[7] Scheidegger, A. E., and Wilson, J. T., *Proc. Geol. Assoc. Canada*, 3, 167 (1950).
[8] Bullard, E. C., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 36 (1950).

Tensile Strength of Liquid Nitrogen

Several authors[1] have suggested that included gases have an appreciable effect in lowering the observed tensile strength of a liquid. For this reason it was decided to attempt to measure the tensile strength of a low-temperature liquid which, when cooled below its normal boiling point, would contain none of the normally included gases found in most liquids.

A review of the available experimental methods[2] of measuring the tensile strength of a liquid suggests that the static and dynamic tensile strengths of liquids are different. Since the tensile strength of a solid is a static concept, it seems reasonable to consider the static tensile strength of a liquid as a true measure of its tensile strength. For this reason an adaptation of Vincent's bellows method[3] was used. The apparatus was designed with a spring-loaded bellows, and the whole assembly was immersed in the liquid under test. The tension on the liquid-filled bellows could be varied by adjusting the extension of the spring until the tensile strength of the liquid was reached and the rupture of the liquid column ensued. The maximum observed tensile strength of liquid nitrogen was found to be 3·5 atmospheres at 71·0° K., while the maximum theoretical tensile strength based on the theory of Volmer[4] was calculated to be 60 atmospheres at the same temperature.

An attempt was made to study the tensile strength of liquid nitrogen as a function of temperature. It appears that no apparent relation exists between temperature and observed tensile strength, although one would be expected from previous theoretical work[4,5]. It is possible to explain this fact and the discrepancy in observed and predicted values of tensile strength by assuming a bubble-trapping process in the small surface cavities of the bellows. This suggestion has been made previously[1] to explain the lowering of tensile strength of a liquid by the trapping of bubbles of included gases in the Griffith's cracks in the wall of the container. In our case,

however, the process will not depend on the trapping of bubbles of normally included gases, but on the trapping of bubbles of nitrogen gas in the walls of the container, the size of the nitrogen gas bubble in the liquid being defined by the existing temperature and pressure of the system.

It is hoped to continue the experiments with liquid helium both above and below the λ-point.

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[1] Kuper and Trevena, *Proc. Phys. Soc.*, **65**, 46 (1952). Benson and Gerjuoy, *J. Chem. Phys.*, **17**, 914 (1949). Vincent, R. S., *Proc. Phys. Soc.*, **55**, 41 (1941).
[2] Temperley and Chambers, *Proc. Phys. Soc.*, **58**, 421 (1946).
[3] Vincent, R. S., *Proc. Phys. Soc.*, **53**, 126 (1941).
[4] Bernath, L., *Indust. and Eng. Chem.*, **44**, 1310 (1952).
[5] Temperley, H. N. V., *Proc. Phys. Soc.*, **59**, 199 (1947).

Paramagnetic Resonance and Covalent Bonding

In the course of a programme of investigating paramagnetic resonance in compounds containing 4*d* and 5*d* transition elements, we have recently found an unusual hyperfine structure in ammonium chloroiridate, which gives information about the bonding in this compound. The essential experimental result is that in a crystal of $(NH_4)_2$ $[IrCl_6]$, diluted with the isomorphous diamagnetic platinum salt, the resonance spectrum at a temperature of 20° K. and wave-length of 1 cm. shows a complex hyperfine structure consisting of many lines, of which sixteen equally spaced lines can be resolved in the most favourable directions, with overall separation of about 150 gauss. At first sight one would expect only four lines corresponding to the known nuclear spins ($I = 3/2$) of iridium-191 and 193. (The nuclear magnetic moments are approximately equal.) It is possible to explain the presence of the additional lines as arising from the chlorine-35, 37 ($I = 3/2$) nuclei, and the detail of the spectrum by assuming that the hyperfine structure of chlorine is one-third of that of the iridium.

Each iridium ion lies at the centre of a regular octahedron of chlorine ions, and on a purely ionic model these ions would be Ir^{4+} ($5d^5$) and Cl^- (an inert gas structure). The susceptibility of the complex corresponds approximately to that of a single electron spin, and using Van Vleck's theory[1], this would be interpreted as arising from a hole in the d_{xy}, d_{yz}, d_{zx} shell. Van Vleck shows how this result can be reached either by the directed valence bond, or the strong crystal field, or the molecular orbital approach; although in the molecular orbital method he only considers combinations between orbitals such as $d_{x^2-y^2}$, d_{3z^2-r} (central ion) and p_σ (attached ions). The experimental evidence in ammonium chloroiridate suggests that the magnetic hole is described by admixtures of $3p_\pi$ (Cl) orbitals with $5d_{xy}$, d_{yz}, d_{zx} (Ir) orbitals. This can also be pictured as a mechanism whereby for part of the time an electron is transferred from Cl^- to Ir^{4+}, cancelling the unpaired spin on the iridium, and leaving an unpaired spin on a chlorine atom.

In the paramagnetic resonance spectrum, this leads to two effects, both of which have been observed: (i) there will be a hyperfine structure from the chlorine nuclei, and (ii) the spectroscopic splitting factor will be smaller than $g = 2$, the value given by Van Vleck's theory. From the measured size of the hyperfine structure, and from the observed value, $g = 1{\cdot}8$, we have tentatively estimated that the electron hole is on a particular chlorine atom for about 3 per cent of the time, and on some chlorine atom for about 18 per cent. The paramagnetic resonance method thus gives a direct and quantitative measure of π-bonding, or, crudely, of the whereabouts of the electron hole.

Theoretical and experimental work is proceeding, and we hope soon to look for similar phenomena in other compounds, particularly potassium bromoiridate. All this work will be reported more fully in due course.

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[1] Van Vleck, J. H., *J. Chem. Phys.*, **3**, 807 (1935).

Dielectric Relaxation Time of Polar Molecules in Solution

Measurements of the dielectric relaxation time (τ) of a polar substance (B) in a non-polar solvent (A) are usually interpreted in terms of the generalized Debye formula[1]:

$$\tau = (8\pi\eta_A a_B^3)/2kT, \qquad (1)$$

where η_A is the viscosity of the solvent, and a_B is the radius of the solute molecule.

A closer examination of the processes involved shows that this extension of Debye's formula to a solution is not justified, because η_A is determined by the interaction between the solvent molecules, whereas τ is determined by the interaction between non-polar and polar molecules.

In a discussion to be published elsewhere, it is shown that, for a very dilute solution,

$$\tau = (A\eta_{AB})/2kT, \qquad (2)$$

where A is a function of the moments of inertia and masses of the two types of molecule, and the intermolecular distances, and is of the same order of magnitude as a_B^3, and η_{AB} is the 'mutual viscosity'

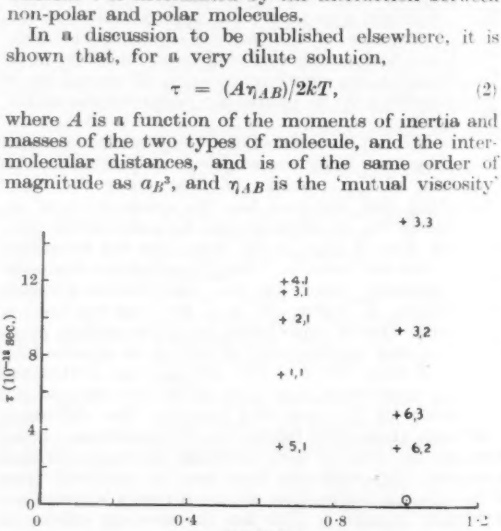

Fig. 1. Relaxation time and solvent viscosity. Numbers at points refer to solute and solvent respectively. Solutes: 1, phenyl chloride; 2, phenyl bromide; 3, phenyl nitrite; 4, phenyl propionate; 5, methyl acetate; 6, chloroform. Solvents: 1, benzene; 2, *cyclo*hexane; 3, carbon tetrachloride. For the point marked by a circle, both scales should be multiplied by 200

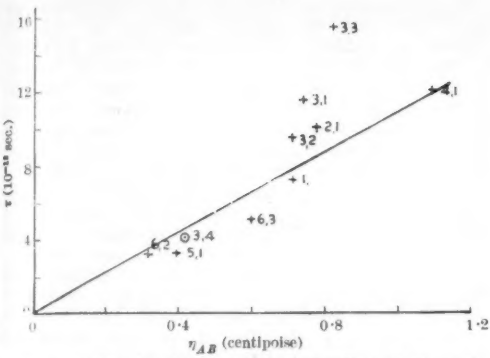

Fig. 2. Relaxation time and mutual viscosity. Numbers at points have the same significance as in Fig. 1. For the point marked by a circle both scales should be multiplied by 10

of the two substances, which can be found from the viscosity of the mixture, since

$$\eta\sigma = f_A^2\eta_A\sigma_A + f_B^2\eta_B\sigma_B + 2f_Af_B\eta_{AB}\sigma_{AB}, \qquad (3)$$

where the f's are mole fractions, the σ's are intermolecular distances, and terms without suffix refer to the mixture.

Relations (2) and (3) are derived using Andrade's[2] model of a liquid.

Figs. 1 and 2 show τ plotted as a function of η_A and of η_{AB} respectively for various polar solutes in benzene (η = 0·65 c.poise), *cyclo*hexane (η = 0·97 c.poise), carbon tetrachloride (η = 0·97 c.poise) and medicinal paraffin ($\eta \sim 200$ c.poise). The relaxation times are taken from the results of Whiffen and Thompson[3], and of Curtis, McGreer, Rathmann and Smyth[4]. The values of η_{AB} are deduced from data given in the "International Critical Tables" for solutes in benzene, and from measurements I have made in other cases.

From the graphs it can be seen that there is no simple relation between τ and η_A, as required by the Debye formula; but that the graph of τ against η_{AB} does approximate to a straight line through the origin as required by equation (2). Deviations from the linear relation may be interpreted as reflecting variations of the function A of the molecular sizes.

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[1] Debye, P., "Polar Molecules" (New York, 1929).
[2] Andrade, E. N. da C., *Phil. Mag.*, **17**, 497 (1934).
[3] Whiffen, D. H., and Thompson, H. W., *Trans. Farad. Soc.*, **42** A, 114 (1946).
[4] Curtis, A. J., McGreer, P. L., Rathmann, G. B., and Smyth, C. P., *J. Amer. Chem. Soc.*, **74**, 644 (1952).

A.C. Operation of Ion Chambers

MEASUREMENT of low-intensity ionization in an ion chamber involves the amplification of very small currents. D.C. operation is conventional; but it is difficult to provide stable valve amplification of a weak D.C. signal. Conversion to A.C. by a vibrating-reed gives good sensitivity and stability, but the mechanical device is elaborate. A.C. operation and amplification appears to be stable and simple, and is capable of high sensitivity.

The current produced by irradiation in the A.C. case is caused not primarily by the collection of ions but by the oscillation of a space charge within the chamber. This builds up slowly to its equilibrium density after a source of radiation is brought near the chamber, giving slow response time but high sensitivity. With the bridge circuit described for 10 c./s. operation, an irradiation sensitivity equivalent to 10^{-14} amp. D.C. may easily be obtained; the current rises to its maximum value with a time-constant of about ½ min.

Kiehn[1] has described a single ion-chamber in a Wien bridge operated at 150 c./s. The high frequency gives rapid response times but reduced sensitivity. The apparatus developed in the present investigation was designed for high-sensitivity measurements of strontium-90 – yttrium-90 bremsstrahlung radiation.

Two T.P.A. (gamma-sensitive) ion chambers, filled with argon at 20 atmospheres pressure, are connected in opposition as two arms of an A.C. bridge; each balance arm consists of adjustable capacity and parallel resistance. The bridge is fed with 10 c./s. at 24 volts. Out-of-balance current is detected by an amplifier with electrometer triode input; the amplified signal is led to a 'gate' pentode where it is filtered for both frequency and phase, and the smoothed anode current measured on the output meter. The bridge is easily balanced to eliminate all capacitive current through the ion chambers, and much of the cosmic background current as well. Irradiation of either chamber separately causes additional resistive current to flow in the chamber; the output meter shows a change in reading proportional to the radiation intensity over a small range. The sensitivity is limited by variations in the balanced background currents to a value of about 2 microcuries radium at 100 cm. from one chamber.

This work will be reported in detail elsewhere.

I wish to thank Dr. D. Taylor and members of the Counters Group at the Atomic Energy Research Establishment, Harwell, for their advice and help.

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[1] Kiehn, R. M., *U.S.A.E.C.U.*, 1630, Argonne (Aug. 1951).

Atmospherics with Very Low-frequency Components

THE low-frequency (*c.* 100–500 c./s.) or 'slow tail' component in the wave-form of an atmospheric was first studied in detail by Watson-Watt, Herd and Lutkin[1]. They defined two parameters: the delay t as the time elapsing between the start of the main oscillatory section of the atmospheric and the commencement of the slow tail, and the quarter-period $\tau/4$ as the time occupied by the first quarter-cycle of the tail. Both t and $\tau/4$ were found to increase in a somewhat irregular, non-linear, manner, as the distance of origin, D, of the atmospheric increased.

An extensive programme of observations of slow tails has recently been completed at the Cavendish Laboratory. Throughout the programme, the kind co-operation of the Meteorological Office "Sferics" Organization[2] has greatly enhanced the value of the work by locating the sources of individual wave-forms. Although it was noted that, for any estimated distance and any hour of the day, the individual values obtained for t and $\tau/4$ showed considerable scatter, the results, when averaged, were found to be represented for distances up to 5,000 km. by two

simple linear equations. With t and $\tau/4$ in μsec., and D in km.: $t = k(D - D_0)$, where $D_0 \sim 1{,}000$ km., and $\tau/4 = \tau_0 + cD$, where $\tau_0 \sim 500$ μsec.

The constants k and c have significantly different values by day and by night; in day-time, $k(d) = 0{\cdot}33$ and $c(d) = 0{\cdot}23$; at night, $k(n) = 0{\cdot}13$ and $c(n) = 0{\cdot}08$.

The transition from day-time to night-time was observed to occur gradually; the steady night-time conditions only became established some three hours after the latest time of ground sunset along the path of the atmospheric.

Many of the features in an atmospheric wave-form may be interpreted by examining the propagation of a primary pulse in the wave-guide formed by the earth and the lower boundary of the ionosphere[3]. This approach is especially applicable to low-frequency effects, since only one or two wave-guide modes, at most, are concerned, and Hales[4] has indicated how the slow-tail phenomena may be explained by considering propagation between a perfectly conducting earth and an ionosphere of finite conductivity. From the present results it is possible, on Hales's theory, to derive a range of solutions for h, the height of the ionospheric stratum involved, and σ its conductivity; but neither can be determined separately. Estimates are, however, available from other sources for the electron and ion density and collisional frequency at various levels in the ionosphere, and hence for the variation of σ with h, ignoring any effects due to the earth's magnetic field. Using these estimates, it is found that the slow-tail results by day indicate propagation between the earth and an equivalent, homogeneous, ionospheric layer of height 65 km. and conductivity 5×10^3 e.s.u.; at night the height of the layer is 90 km. and the conductivity 11×10^3 e.s.u.

It is hoped to publish a fuller account of this work elsewhere. This programme received financial assistance from the Department of Scientific and Industrial Research.

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[1] Watson-Watt, R. A., Herd, J. F., and Lutkin, F. E., *Proc. Roy. Soc.*, A, **162**, 267 (1937).
[2] Ockenden, C. V., *Met. Mag.*, **76**, 78 (1947).
[3] Budden, K. G., *Phil. Mag.*, **42**, 1 (1951).
[4] Hales, A. L., *Proc. Roy. Soc.*, A, **193**, 60 (1948).

Paper Chromatography of Phosphate Esters

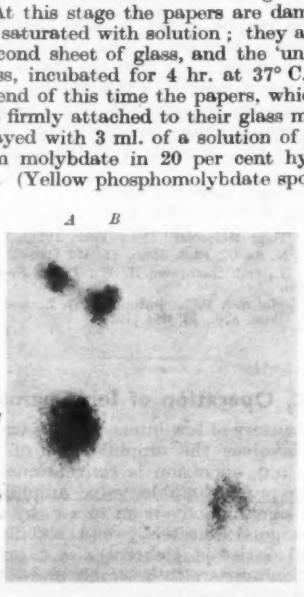
The demonstration of phosphate esters on paper chromatograms has hitherto depended upon purely chemical methods for the liberation of the bound phosphate groups[1]. The specificity of these techniques might be a matter of some doubt and cause difficulties of interpretation when they are applied to chromatograms of unknown material obtained from a biological source. They also suffer from the disadvantage that the ease with which different organic phosphate esters are hydrolysed varies considerably, and the application of the method to esters which are not readily acid-labile, such as glucose-6-phosphate or phosphoglyceric acid, is sometimes uncertain[2].

In an attempt to overcome these deficiencies, we have developed an enzymic method, in which a solution of alkaline phosphomonoesterase, prepared by the method of Schmidt and Thannhauser[3], is used to liberate orthophosphate from the esters resolved on the chromatogram. The tendency for the resolved spots to spread and become diffuse when sprayed with the aqueous enzyme solution has been successfully countered by first spraying with a solution of calcium chloride in ethanol; any phosphate afterwards liberated on this impregnated paper at an alkaline pH is precipitated as insoluble calcium phosphate at the site of its liberation, and the compactness of the resolution is thus maintained. By this use of alkaline phosphatase, the paper chromatography of phosphate esters should gain both in specificity and in reliability of detection within the wide substrate range of the enzyme[3].

We have used Whatman No. 1 papers, 28 cm. square, washed for 10 hr. in 0·1 *N* hydrochloric acid, then successively in running tap water and in distilled water, and finally dried at 70° C. The solvents used by Bandurski and Axelrod[2] and the two-dimensional development described by them were adopted with only slight modifications: formic acid was replaced by an equal volume of acetic acid in the acid solvent, and we usually ran our chromatograms in the basic solvent first.

After development by the two solvents, our procedure is as follows: the papers are thoroughly air-dried at room temperature, mounted on glass sheets slightly larger than the papers themselves, and sprayed with 10 ml. of a 5 per cent solution of $CaCl_2.6H_2O$ in 80 per cent ethanol. The ethanol is allowed to evaporate at room-temperature, and the papers are then sprayed with 10 ml. of the enzyme solution prepared in 0·1 *M* glycine buffer at pH 9. (In our experiments the various enzyme solutions used liberated 50–200 μgm. phosphorus per ml. in 5 min. at 37° C. from an added excess of glucose-1-phosphate.) At this stage the papers are damp, but by no means saturated with solution; they are covered with a second sheet of glass, and the 'units', glass–paper–glass, incubated for 4 hr. at 37° C.

At the end of this time the papers, which are still damp, are firmly attached to their glass mounts and finely sprayed with 3 ml. of a solution of 5 per cent ammonium molybdate in 20 per cent hydrochloric acid (v/v). (Yellow phosphomolybdate spots quickly



Section of chromatogram showing resolution of: *A*, sodium glycerophosphate; *B*, 3-phosphoglycerate; *C*, glucose-1-phosphate; *D*, adenosine-5-phosphate

appear where orthophosphate has been liberated in amounts equivalent to 1 μgm. phosphorus or more.) After standing for 2 min., the papers are further sprayed with 5 ml. benzidine solution (50 mgm. benzidine hydrochloride dissolved in 10 ml. glacial acetic acid and diluted with water to 100 ml.), using a fume cupboard with a good draught. They are then inverted over a trough of ammonia (sp. gr. 0·880, diluted 1 : 4) at a distance of 2 in. from the surface of the liquid, when the positions of liberated phosphate groups are shown by the appearance, within a minute, of bright blue spots which show distinctively on a white ground. 0·5 μgm. phosphorus is readily detected by this method. Over-exposure to ammonia at the final stage leads to rapid fading of the blue colour.

The accompanying photograph shows a resolution involving four typical phosphate esters: sodium glycerophosphate, 3-phosphoglycerate, glucose-1-phosphate and adenosine-5-phosphate.

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[1] Hanes, C. S., and Isherwood, F. A., *Nature*, **164**, 1107 (1949). Benson, A. A., Bassham, J. A., Calvin, M., Goodale, T. C., Haas, V. A., and Stepka, W., *J. Amer. Chem. Soc.*, **72**, 1710 (1950). Burrows, S., Grylls, F. S. M., and Harrison, J. S., *Nature*, **170**, 800 (1952).
[2] Bandurski, R. S., and Axelrod, B., *J. Biol. Chem.*, **193**, 405 (1951).
[3] Schmidt, G., and Thannhauser, S. J., *J. Biol. Chem.*, **149**, 369 (1943).

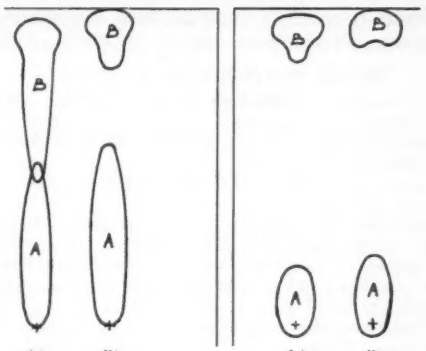

Fig. 1 Fig. 2

Chromatograms (Fig. 1, Whatman No. 1 paper; Fig. 2, Schleicher and Schüll No. 1101 *L* paper) of 20 μgm. salicylic acid (*a*) and sulphosalicylic acid (*b*) developed with water. *A*, acid-spot visible after spraying with neutralized methyl red; *B*, salt-spot sprayed with ferric chloride; +, place of initial spot

Ion Exchange in Paper Chromatography

It has been shown by Schute that several mixtures of alkaloids can be separated by chromatography on paper using aqueous ammonia[1]. Because the chromatograms have the characteristics of a partition chromatogram, it is probable that the above separation is due to partition between an aqueous imbibition phase and an aqueous mobile phase.

It was also possible to show that, when the cellulose is not swollen (that is, it contains chemically bound water only) and the solvent is hexane, irreversible surface adsorption of alkaloids occurs[2]. An alkaloid can be displaced from the adsorbed state by a more polar one, and therefore it is probable that this adsorption is of a polar nature. Hence we may expect that the adsorption will decrease when the solvent becomes more polar. Moreover, when the cellulose is swollen by the solvent, an important part of the cellulose ceases to be a surface phase and becomes a volume phase. Surface adsorption on cellulose from a strongly polar and swelling solvent such as water is therefore very improbable.

However, when acids and alkaloids are chromatographed on paper with water as a solvent, irreversible 'absorption' takes place. It can be shown that this is caused by ion exchange. When an aqueous solution of an acid (HZ) is in contact with paper, the hydrogen ions of the acid exchange with the cations (M_p^+) of the paper: $HZ \rightleftarrows H^+ + Z^-$ and $H^+ + M_p^+ \rightleftarrows H_p^+ + M^+$. Here M_p^+ represents ions of sodium, potassium, calcium, magnesium, etc., bound on carboxyl groups, silicate and other 'insoluble material'.

As the combination $M^+ + Z^-$ is chromatographed further and H^+ cannot be eluted from H_p^+ by pure water, the H^+ and Z^- of the acid can be completely separated (Figs. 1 and 2). When the acid-spot *A* is separated from the salt-spot *B*, the area of *A* gives a measure of the total amount of exchangeable cation M_p^+. This amount is greater for the Schleicher and Schüll paper than for the Whatman paper.

When blank paper is chromatographed with water, electrolyte is eluted and the solvent contains cations, the concentration of which increases with the distance covered by the front. Because the H^+ is exchanged from the H_p^+ area by this electrolyte, the rear boundary of this area is removed farther from the initial spot, when this spot has been placed farther from the base. This phenomenon disappears almost completely when the paper is first washed 'chromatographically' with water. However, when washed paper is chromatographed with water for a second time, electrolyte is eluted again from the paper. This may be explained by the reaction:

$$M_p^+ + H_2O \rightleftarrows M^+ + OH^- + H_p^+,$$

a hydrolysis corresponding to the 'membrane hydrolysis' of Donnan, as suggested by Hirsch[3]. Thus, in washed paper, part of the exchangeable cation has already been displaced by hydrogen ion, and this agrees with the fact that the area of the acid spot increases on washing the paper with water. This must be taken into consideration when we wish to determine the amount of M_p^+ by measuring the acid area.

In Fig. 1 the front part of the acid spot from salicylic acid contains salicylate. In this part there is still unchanged salicylic acid, and it appears that this acid travels much more slowly than the solvent front (R_F about 0·5).

When the paper is washed 'chromatographically' with hydrochloric acid and next with water to remove the excess of acid, all exchangeable M_p^+ is displaced by H^+ (H^+ paper). When salicylic and sulphosalicylic acid are chromatographed with water on this H^+ paper, normal chromatograms occur and both acids are separated, the R_F's being about 0·55 and 0·70 respectively when Whatman No. 1 paper is used.

As ion exchange on this paper is impossible and surface adsorption highly improbable, we may conclude that the separation in this case is caused by partition between imbibition water and mobile water, the imbibition water having properties other than pure water.

When an alkaloid (XN) is chromatographed, ion exchange is possible :

$$XN + H_2O \rightleftarrows XNH^+ + OH^- \text{ and}$$
$$XNH^+ + M_p^+ \rightleftarrows M^+ + XNH_p^+.$$

When H^+ paper is used, direct salt formation will occur :

$$XN + H_p^+ \rightarrow XNH_p^+.$$

It appears that XNH_p^+ is only slightly eluted by pure water, and this gives another possibility of estimating the amount of M_p^+, displacing first the M_p^+ by H_p^+ and measuring the area of an alkaloid bound by the H_p^+.

The alkaloid ion in XNH_p^+ will be exchanged for cations. When the cation is another alkaloid ion which is bound preferentially, the two alkaloids can be separated ; hence mixtures of alkaloids can be analysed by ion exchange on paper with water as a solvent.

It is clear that ion exchange will also occur when the mobile phase is an organic solvent and the stationary phase is an ionizing medium such as water. It is probable that many of the abnormalities occurring in paper chromatography of ionizable substances may be explained, at least partly, by this ion exchange. This is supported by the fact that abnormalities in the chromatography of alkaloids are decreased by impregnating the paper with potassium chloride, as is found by Munier *et al.*[4]. The excess of electrolyte in the stationary phase will make the XNH_p^+ bonding impossible.

This investigation is part of a study of the mechanism of paper chromatography, full reports of which will be published in due course. I thank Prof. E. H. Vogelenzang for his interest and encouragement, and the Dutch Organization Z.W.O. for financial support.

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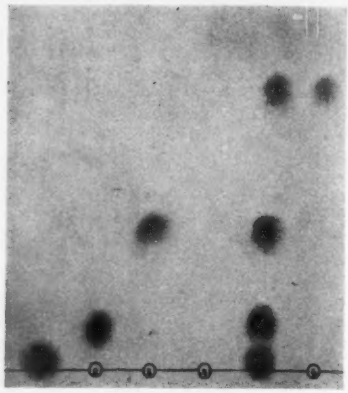
[1] Schute, J. B., *Pharm. Weekblad*, **86**, 201 (1951).
[2] Schute, J. B., Verslag Symposium Chromatografie Utrecht, Mei 1952 (in the press).
[3] Hirsch, P., *Rec. trav. chim.*, **71**, 525 (1952).
[4] Munier, M., Macheboeuf, M., and Chevrier, N., *Bull. Soc. Chim. Biol.*, **34**, 204 (1952).

Paper Chromatography of Thioureas

In the course of a current investigation, it became necessary to separate and identify minute amounts of N-substituted thioureas. Paper chromatography suggested itself as the method of choice for this purpose, and a technique has now been worked out which gives satisfactory and reproducible results on some thirty thioureas investigated, separately or in complex mixtures.

As a result of numerous experiments, water-saturated chloroform was selected as the most satisfactory mobile phase. One-dimensional, ascending chromatograms were run on No. 1 Whatman paper at 23·5° ± 0·1°. The attainment of equilibrium in the chromatographic system presented some preliminary difficulties owing to the high density of the chloroform vapour. This problem was solved, however, by lining the glass walls of the chamber with filter paper soaked in chloroform and water. After equilibration of the sheets (17·5 cm. × 28·5 cm.) for 16–18 hr., the chloroform was allowed to rise 23·0 cm. from the starting line in the course of 110–120 min. Periods much outside this range were indicative of imperfect equilibrium and resulted in less satisfactory results. After development, the air-dried paper was sprayed with Grote's reagent[1] and, upon moderate heating, the thioureas appeared as distinct, deep-blue spots, gradually fading within a day or two. Comparable results were obtained by Feigl[2] on consecutive spraying with a starch solution and the iodine–azide reagent. In this case the thioureas appeared as colourless spots on a uniformly blue background. Owing to a slightly higher sensitivity of Grote's reagent, it was generally preferred throughout the present work.



Chromatogram of N-substituted thioureas developed with Grote's reagent. The substances were applied along the lower line as spots, each containing 0·002 ml. of a 1·0 per cent solution in ethanol. (1) Methyl ; (2) ethyl ; (3) *n*-propyl ; (4) phenyl ; (5) a mixture of methyl-, ethyl-, *n*-propyl, *n*-butyl and phenyl-thiourea, applied as 0·002 ml. of an ethanolic solution containing 1·0 per cent of each component ; (6) *n*-butyl

Even under carefully controlled conditions, some variations in the R_F-values were noticed from one run to another. These fluctuations could be eliminated by including N-phenylthiourea as a reference substance in every run and considering the movement in relation to this arbitrary standard. For convenience, we have introduced the term R_{Ph}-value, defined as the ratio between the distances travelled by the individual component and phenylthiourea. The R_{Ph}-values were found to be reproducible within ± 0·01. In the accompanying table, results are presented for a few typical mono-substituted thioureas. Di-, tri- and tetra-substituted thioureas were also successfully separated ; but S-substituted *iso*-thioureas did not respond to Grote's reagent. A series of thiobarbituric acids were separated and detected as yellow spots on spraying with the same reagent. However, Grote's reagent proved to be unsuitable for the detection of thiosemicarbazides owing to the varying and often transient nature of the colours produced.

N-Substituent(s)	R_{Ph}-values
Methyl	0·04
Ethyl	0·15
n-Propyl	0·43
n-Butyl	0·84
Allyl	0·26
Benzyl	0·90
*sym.*Dimethyl	0·41
Trimethyl	1·22

Separations of mixtures containing individual components with R_{Ph}-values higher than *c.* 1·20 were often facilitated by using the slow No. 50 Whatman paper.

A fuller account of the work will be published in *Acta Chemica Scandinavica*.

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[1] Grote, I. W., *J. Biol. Chem.*, **93**, 25 (1931).
[2] Feigl, F., "Qualitative Analysis by Spot Tests" (3rd edit., New York—Amsterdam, 1946).

Use of Ion-Exchange Resins in Paper Chromatography of Sugars

THE recent communication by Phillips and Pollard[1] suggests that results obtained here may be of interest. In the paper chromatography of dilute and very impure sugar solutions, such as non-diabetic urines or certain protein hydrolysates, it is common practice to use beforehand a 'mixed bed' ion-exchange resin to remove interfering anions and cations[2]. For example, 'Bio-Deminrolit E', a mixture of a weakly basic resin containing amine groups and a sulphonic acid type resin, is shaken with the solution for 20 min. and, after centrifuging, the clear supernatant contains all the sugars (except amino-sugars and uronic acids) uncontaminated by ionizable substances[3]. When 'Bio-Deminrolit E' was replaced by 'Bio-Deminrolit' or 'Bio-Deminrolit F', which are mixtures of sulphonic acid type resins with strongly basic resins of the quaternary ammonium hydroxide type, it was found that all fructose, glucose, galactose, mannose and fucose were removed from the dilute solutions employed.

The effect was investigated using columns 1 cm. diameter and 2–5 cm. long of 'Amberlite IRA400' (OH form), and it was found that 2 mgm. of glucose, for example, was completely removed from solution by such a column and, with the quantity used, none or at most 10 per cent of the sugar was recoverable by immediate elution with dilute hydrochloric acid. Of the sugars investigated glucosamine[4], galactosamine and N-acetylglucosamine were anomalous in that, while they were completely removed by the resin, they were recovered quantitatively by hydrochloric acid elution. Non-reducing sugars were not investigated.

If 'Bio-Deminrolit' is saturated with carbon dioxide, the quaternary ammonium bicarbonate is formed. The resulting mixed resin is used in this laboratory in place of 'Bio-Deminrolit E' (now unobtainable) and is very satisfactory. There was no appreciable loss of fructose or glucose from a dilute solution of the sugars left over 'Bio-Deminrolit' (HCO_3' form) for nine days at 0 °C.

I wish to thank Mr. J. D. Cheshire and Miss S. D. Birchenough for technical assistance.

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[1] Phillips, J. D., and Pollard, A., *Nature*, **171**, 42 (1953).
[2] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).
[3] Woolf, L., *Great Ormond Street J.*, **1**, 61 (1951).
[4] Piez, K. A., Tooper, E. B., and Fosdick, L. S., *J. Biol. Chem.*, **194**, 669 (1952).

Separation and Structural Determination of the Olefinic Components of Poison Ivy Urushiol, Cardanol and Cardol

THE noxious saps of numerous members of the Anacardiaceæ, such as Japanese lac, poison ivy, cashew nut shell liquid, etc., contain phenolic bodies carrying long unsaturated side-chains attached to the benzene ring. Earlier investigators[1] have in certain cases established the length and the position of these alkenyl side-chains; but prior to the present investigation only very limited information was available concerning the structural details of the unsaturation. There is no doubt, however, that the unsaturation in the side-chain plays an important part both in the physiological properties[2] and industrial uses[3] of these compounds.

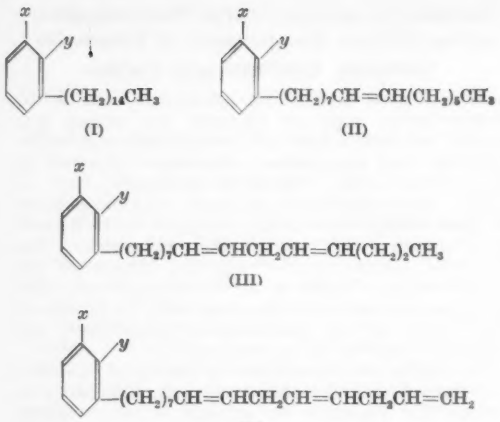
To explain the formation of a variety of oxidative degradation and ozonolysis products, Majima[1] concluded that Japanese lac urushiol is hetero-olefinic in character. He proposed structures for mono-, di- and tri-olefinic components; but he was not able to separate these components for their decisive structural identification. In fact, work now in progress in these laboratories[4] indicates that two of the structures proposed by Majima will have to be modified.

Earlier investigations[5] in this laboratory have established that the alkenyl phenols, anacardic acid and cardanol (also called anacardol[1]) obtained from the shell liquid of the cashew nut are also hetero-olefinic in character. However, no evidence has been available concerning the olefinic heterogeneity of cardol, the resorcinol component largely responsible for the dermatitis caused by cashew nut shell liquid[3].

Most of the interest in the United States in regard to the physiological properties of these alkenyl phenols has been focused on poison ivy. The difficulty of obtaining the toxic phenol in pure form from the poison ivy sap has seriously hampered efforts to gain more information about its unsaturated character. Poison ivy urushiol absorbs hydrogen equivalent to about two double bonds and is converted into 3-pentadecylcatechol[1b]. Although Mason and Schwartz[6] concluded on the basis of preliminary chromatographic experiments that at least three toxic components are present in poison ivy urushiol, they did not separate these components in a form suitable for structural elucidation.

By means of chromatographic adsorption of the methyl ethers of three of these alkenyl phenols (poison ivy urushiol, cardanol and cardol) on alumina, we now have been able to separate the different olefinic components in pure form. In the case of poison ivy dimethyl urushiol, four components have been isolated—one of which had a completely reduced side-chain and the other three possessed one, two and three double bonds. Each of the three olefinic components absorbed the theoretical amount of hydrogen on catalytic reduction and yielded in pure form the saturated component (3-pentadecylveratrole). The structures of the four components of poison ivy urushiol now established on the basis of the products isolated from ozonolysis and oxidative degradation involving the dimethyl ether are shown in the accompanying formulæ (p. 842).

Cardanol, the monophenol obtained from the cashew nut shell liquid, was found to absorb hydrogen equivalent to about two double-bonds. Its methyl ether was also separated into four chromatographically pure components, the side-chains of which proved to be identical with those of the corresponding



Components of poison ivy urushiol ($x = y = OH$)

components of poison ivy urushiol. The structures of the pure components of cardanol, therefore, can be represented as I, II, III and IV, respectively, where $x = OH$ and $y = H$.

Anacardic acid, the alkenyl salicylic acid component of cashew nut shell liquid, also absorbs two moles of hydrogen and is hetero-olefinic. On reduction it is converted into 2-carboxy-3-pentadecylphenol. Since anacardic acid gives cardanol on smooth decarboxylation, it seems probable that the hetero-olefinic character of anacardic acid can be explained in terms of olefinic components corresponding in structures to those found in cardanol (I, II, III and IV; $x = OH$, $y = COOH$).

Cardol, the toxic resorcinol component of cashew nut shell liquid, usually absorbs somewhat more than two molar equivalents of hydrogen and is converted into 1,3-dihydroxy-5-pentadecylbenzene. It was found to be composed mainly of a diolefin and a triolefin having alkenyl side-chains identical with those shown above.

No component having more than three double bonds could be detected in any of the three alkenyl phenols investigated.

A detailed account of this work will be reported elsewhere. We are indebted to the Lederle Laboratories Division of the American Cyanamid Company for a grant supporting this investigation. An extract of poison ivy was also supplied by the Lederle Laboratories. The cashew nut shell liquid was kindly supplied by the Irvington Varnish and Insulator Company.

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[1] (*a*) Majima, R., *Ber.*, **55** B, 172 (1922). (*b*) Hill, G. A., Mattacotti, V., and Graham, W. D., *J. Amer. Chem. Soc.*, **56**, 2736 (1934). (*c*) Backer, H. J., and Haack, N. H., *Rec. Trav. Chem.*, **60**, 661 (1941).
[2] Keil, H., Wasserman, D., and Dawson, C. R., *J. Exp. Med.*, **80**, 275 (1944); *Science*, **102**, 279 (1945); *Indust. Med.*, **14**, 825 (1945).
[3] Harvey, M. T., and Caplan, S., *Indust. and Eng. Chem.*, **32**, 1306 (1940).
[4] Sunthankar, S. V., and Dawson, C. R. (unpublished work).
[5] Sletzinger, M., and Dawson, C. R., *J. Org. Chem.*, **14**, 670 (1949). Izzo, P. T., and Dawson, C. R., *J. Org. Chem.*, **14**, 1039 (1949); **15**, 707 (1950).
[6] Mason, H. S., and Schwartz, L., *J. Amer. Chem. Soc.*, **64**, 3058 (1942).

Specific Volume of Cellulose in Aqueous Solutions of Inorganic Salts

The specific volume of cellulose (sheet viscose) in aqueous solutions of ammonium, sodium and potassium chlorides, at 25° C., has been measured, using a 'hydrostatic balance', for the whole of the solubility range of the salt.

The curve obtained in the plot of specific volume against concentration passes through a maximum in each case. The concentration of the external solution at the maximum specific volume for each salt is:

Salt	Concentration (wt. per cent)
Ammonium chloride	14·3
Sodium chloride	18·0
Potassium chloride	16·0

Calculation of the ratio of gram molecules of water per gram cation at this concentration, assuming equal hydration of anion and cation in all cases, gives the following values:

Ion	Ratio
NH_4^+	8·9
Na^+	7·5
K^+	11·6

From the effective radius of the ion[1] and of the water molecule, the number of water molecules which can be arranged around each ion, from purely geometrical considerations, may be calculated:

Ion	Radius (A.)	'Geometrical' number of water molecules
NH_4^+	1·42	12·0
Na^+	0·95	7·5
K^+	1·33	12·0
H_2O mol.	1·38	12·0

The following suggestion is offered in explanation of the specific volume curve.

There is evidence[2] for believing that, in the initial stages of water adsorption by cellulose, the water is under a compressive force, causing it to have a density greater than ordinary liquid water.

Addition of a salt provides polar centres which disorganize the water atmosphere, and has a decompressing effect on the adsorbed water layer. The specific volume of the cellulose therefore increases with increasing salt concentration, until the activity of the water in the system is so reduced that it is unable to satisfy the hydration requirements of the ions. Further addition of salt then results in direct linkage of the salt ions with the cellulose, and the specific volume decreases once more.

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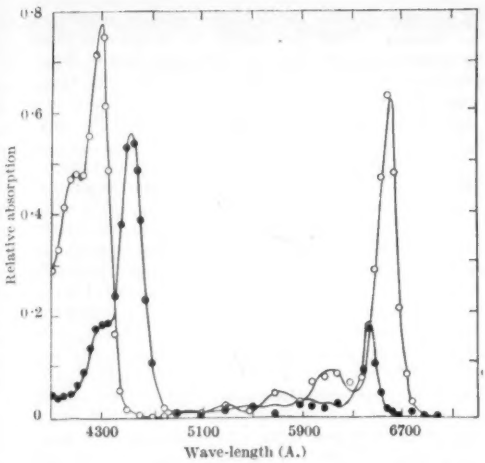
[1] Goldschmidt, *Trans. Farad. Soc.*, **25**, 253 (1929).
[2] Davidson, *J. Text. Inst.*, **18**, T175 (1927). Filby and Maass, *Canad. J. Res.*, **7**, 162 (1932). Stamm and Seborg, *J. Phys. Chem.*, **39**, 133 (1935).

Absorption Spectra of the Ethyl Chlorophyllides

The spectra of the ethyl chlorophyllides, the crystalline derivatives of chlorophyll by replacement of the phytyl by the ethyl radical, are of interest as these compounds are valuable as actinometry standards in the study of the efficiency of photosynthesis. No report seems to have been made of



Absorption spectra of the ethyl chlorophyllides in ether. Solid lines, absorption spectra of chlorophylls *a* and *b*, from Harris and Zscheile (ref. 2); open circles and filled circles, relative absorption coefficients for ethyl chlorophyllides *a* and *b* respectively

their absorption spectra, except for some indirect evidence that they are different from those of the chlorophylls[1].

This has now been tested directly. A sample of the mixed chlorophyllides, which had originally been prepared by A. Stoll, was kindly supplied by Dr. J. Weiss. This sample was dissolved in petroleum ether and chromatographed by the method employed for the chlorophylls[2]. A dark residue remained within ½ mm. of the top of the column. This probably accounts for part of the spectral results previously obtained. The two bands of the chromatogram were twice re-chromatographed.

The spectra of the two chlorophyllides in ether and methanol were measured using a Beckman spectrophotometer. These spectra could then be superimposed exactly on the corresponding chlorophyll spectra[2] on adjustment of the absorption coefficients at one point, as is illustrated in the diagram. An attempt was made to obtain the absolute extinction coefficients by direct weighing after extracting the dissolved sugar with water. This was unsuccessful, as the chlorophyllides were altered in spectra by this treatment. Despite the lack of the absolute extinction coefficients, the identity of spectral shape leaves little doubt that the spectra of the ethyl chlorophyllides are the same as those of the corresponding chlorophylls.

This work is part of a study of chlorophyll *in vitro* being carried out under the direction of Prof. R. Livingston, of the University of Minnesota, and supported by the U.S. Office of Naval Research (Contract N6 ori—212).

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[1] Rabinowitch, E. I., and Weiss, J., *Proc. Roy. Soc.*, A, **162**, 251 (1931).
[2] Harris, D. G., and Zscheile, F. P., *Bot. Gaz.*, **104**, 515 (1943).

Electrolytic Polishing of Lead in a Sodium Acetate–Acetic Acid Bath

In the course of experimental work on the anodic behaviour of lead, it was found desirable to produce a high degree of polish on specimens which might have overall areas of as little as 1 sq.cm. An examination of the literature indicated that the recommended bath for polishing this metal was one consisting of 250 c.c. of 60 per cent perchloric acid, with 750 c.c. glacial acetic acid. We considered that, because of the intermittent use that would be made of the solution, it would be unpleasant to store; a search was therefore made for alternatives. The experiment was tried of increasing the conductance and buffer capacity of glacial acetic acid by the addition of sodium acetate, and the present note gives details of useful operating conditions for electrolytic polishing in the resultant solution.

For most of our experimental work, we employed cylindrical lead specimens, about 1 cm. in diameter and mounted with the exposed face vertical. The electrical connexion to the back surface, and also this surface, were coated with a thermal-setting insulating varnish. A graphite or platinum cathode was placed about 5 cm. away from the anode. Contrary to normal practice the current, rather than the applied voltage, was controlled, and by this means the specimen could be etched or polished. Polishing occurred at current densities between 50 and 100 mA./cm.^{2} in a bath of the following composition:

Anhydrous sodium acetate	60 gm.
Glacial acetic acid	315 c.c.
Water	80 c.c.

The over-potential at the anode has been measured by means of a Luggin capillary and saturated calomel electrode, and a value of 4–5 V. was recorded during polishing. Polishing occurred in the following stages on the 1-cm. diameter specimens: (*a*) etching; (*b*) polishing began at the edges, working inwards across the surface, followed by the inward growth of a film; (*c*) after about two minutes, this film completely covered the surface, the over-potential reaching a maximum value; oxygen was not evolved; (*d*) patches of polish began to show, and after four minutes a highly reflecting surface appeared which was maintained on continuing to pass the current.

If the current is interrupted for a few seconds, on re-starting the above cycle is repeated, etching being first produced on the smooth surface.

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Natural Origin of Optically Active Substances and Optical Resolution by Symmetric Agents

The communication by R. C. Ferreira[1] stresses the implications of his findings (and those of H. M. Powell[2]) on the origin of 'molecular dissymmetry' in living matter through nucleation of a saturated solution of an externally compensated compound by a crystal containing an excess of one enantiomer. Possibly certain earlier work bearing upon the same fundamental principle runs some danger of being overlooked. It was observed more than a hundred

years ago[3] that a solution of externally compensated ammonium hydrogen malate upon evaporation deposited crystals containing about three parts of the (−)-salt to one part of the (+)-salt, showing that a partial spontaneous resolution had taken place.

A remarkable susceptibility to nucleation was recorded by Anderson and Hill[4], who showed that when optically inactive atropine sulphate was crystallized in a laboratory in which the (−)-form had been racemized, the first crop was almost invariably (−)-rotatory, owing to inoculation from the atmosphere. It has even been established that effective nucleation of this kind may be brought about by crystals composed of *symmetric* molecules. In 1908, Ostromisslensky[5] described the optical resolution of externally compensated asparagine through nucleation with crystals of glycine, $CH_2(NH_2).COOH$, as follows: "Beim Impfen der übersättigten wässrigen *d,l*-Asparaginlösungen mit vereinzelten Glykokollkrystallen scheidet sich bald die rechte, bald die linke Antipode aus. Es ist in diesem Falle nicht möglich vorauszusehen, welche der beiden Antipoden ausgeschieden wird, weil die Hemiedrie des Glykokolls nur in vollständig versteckter Form auftritt".

The bearing of such phenomena upon the origin of optically active organic substances in Nature was expressed, for example, in 1926, as follows[6]: "A solution of a substance susceptible to spontaneous separation dries up by natural evaporation and deposits a conglomerate of the two kinds of crystals. One of these crystals is introduced fortuitously into an adjacent supersaturated solution of the substance. It is known that under such conditions a crystalline separation may occur of the optical isomer similar to the inoculating crystal. Imagine at this point that the mother-liquor is drained from the crystalline deposit by a further natural process. Two optically active nuclei are now available, namely, the crystalline separation and the substance remaining in the mother-liquor".

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[1] Ferreira, R. C., *Nature*, **171**, 39 (1953).
[2] Powell, H. M., *Nature*, **170**, 155 (1952).
[3] Pasteur, L., *Ann. Chim.*, **34**, 46 (1852). van 't Hoff, J. H., and Dawson, H. M., *Ber.*, **31**, 528 (1898).
[4] Anderson, L., and Hill, D. W., *J. Chem. Soc.*, 993 (1928).
[5] Ostromisslensky, I., *Ber.*, **41**, 3041 (1908).
[6] Read, J., "Text-Book of Organic Chemistry", 354 (London, 1947). Also in the original edition of 1926.

Repetitive Post-Synaptic Discharge in a Sensory Nucleus

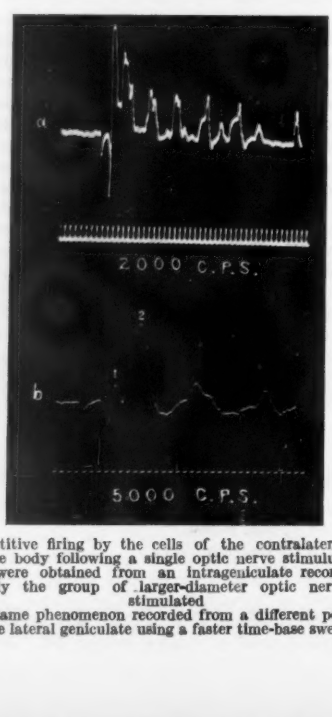
In the course of an investigation into the mechanism of synaptic transmission in the dorsal nucleus of the lateral geniculate body of the cat, the phenomenon of repetitive firing by the ganglion cells has been repeatedly observed following a brief electrical stimulus to the optic nerve.

Extensive electrophysiological studies in this laboratory have shown that the optic nerve and tract contain two groups of fibre sizes. This is clearly shown when only the crossed or uncrossed components of the optic tract are stimulated separately. The fibre groups in the crossed pathway, however, conduct somewhat more slowly than the corresponding groups in the path that remains uncrossed at the chiasm. This fact tends to obscure a clear-cut demonstration of the two groups in the fibre-size spectrum of the optic nerve. The form of the compound action potential of the optic nerve and its relation to the fibre-size spectrum will be reported in detail elsewhere.

By electrical stimulation of the optic nerve, it is possible to activate the group of large-diameter fibres in the opposite tract without significantly affecting the smaller-diameter fibres. In these circumstances a micro-electrode within the corresponding lateral geniculate records the typical waveform shown in record (*b*). It has been shown to consist of an initial positive negative diphasic wave (1) representing the arrival of impulses along optic tract fibres, followed after a short delay by post-synaptic activity leading to the discharge of impulses along optic radiation fibres. The post-synaptic discharge (2) has been shown to consist of a negative positive diphasic radiation spike superimposed upon and initiated by a negative synaptic potential. This wave (2) may be termed the primary post-synaptic response; but in most preparations it may be seen to be followed after a delay of 2–4 m.sec. by another negative wave which represents the beginning of the secondary response. The latter is attributed to repetitive firing or after discharge on the part of the optic radiation neurones.

Record (*a*) shows the same response on a slower time-base sweep. As many as ten distinct secondary spikes have been seen, and they occur at fairly regular intervals of 1·5–3·0 m.sec. The repetitive discharge is prevented, without significantly affecting the primary response, by increased rate of stimulation (greater than 2 per sec.), increased depth of anæsthesia (dial or nembutal) or by mild asphyxia.

The spikes of the secondary response are frequently clearly diphasic, negative positive, and appear to arise out of a synaptic potential. This similarity in form to the primary response suggests that the spikes



(*a*) Repetitive firing by the cells of the contralateral lateral geniculate body following a single optic nerve stimulus. These records were obtained from an intrageniculate recording site with only the group of larger-diameter optic nerve fibres stimulated

(*b*) The same phenomenon recorded from a different position in the lateral geniculate using a faster time-base sweep

represent impulses discharged along optic radiation fibres.

Repetitive firing has been previously reported in sympathetic ganglia[1] and in motoneurone pools[2]. The repetitive firing in the lateral geniculate is not related to the former, for in sympathetic ganglia the phenomenon is not observed unless the ganglia are conditioned by a tetanus of at least 50 stimuli per sec., whereas in the case of the lateral geniculate it is prevented by a stimulation-rate greater than 2 per sec. The phenomenon is probably due to internuncial activity, which also forms the basis of the after-discharge from motoneurone pools. It is suggested that in the lateral geniculate the discharge is the result of the activity of a large number of relatively simple reverberating circuits arranged in parallel array, each possessing an optic radiation neurone and one or more interneurones.

Histological studies provide good evidence for the existence of short axon cells in the lateral geniculate, and recurrent collaterals from optic radiation neurones have been described. It appears that repetitive firing by the lateral geniculate is a normal response under these experimental conditions. The observations of Lloyd and McIntyre on the gracile and cuneate nuclei[3] make it likely that repetitive firing is a property of these nuclei also. These findings suggest a more important role for the sensory nuclei in the organization of sensory impulses than is generally supposed.

This investigation was aided by grants from the National Health and Medical Research Council of Australia and the A. E. Kahn Donation.

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[1] Larrabee, M. G., and Bronk, S. W., *Fed. Proc. Soc. Exp. Biol., N.Y.*, **5**, 60 (1946).
[2] Lorente de Nó, R., *J. Neurophysiol.*, **1**, 207 (1938).
[3] Lloyd, D. P. C., and McIntyre, A. K., *J. Neurophysiol.*, **13**, 39 (1950).

Vitamin B_{12} Content of Calf Thymus Extract

Thymus and thymus extracts have been reported by Asher[1], Rowntree, Clark and Hanson[2], and others using rats as test animals, to have a growth-stimulating effect. Later experiments did not confirm this observation[3,4]. The conflicting results may have been due to deficient diet given to the control animals of the earlier investigators[4], or to the varying value of the calf thymus extracts used. No generally accepted explanation, however, has been found for the growth results. Hammar[5] was of the opinion that some vitamin of the B group may be a contributing factor.

The necessity of an animal protein factor for the growth of several animals has been proved in recent times. This animal protein factor has been regarded as either identical with vitamin B_{12} or as containing vitamin B_{12}. In rats, the growth-stimulating effect of vitamin B_{12} appears so distinctly that their growth is employed as an assay method for this vitamin[6].

We have endeavoured to determine the vitamin B_{12} content of a calf thymus extract used in growth experiments[2-4]. The thymuses were taken from freshly slaughtered calves and preserved deep-frozen. The calves were classified into three age groups: 2–4 weeks, 3–4 months and more than 6 months old. The first two groups had been on a milk diet, whereas the third had received ordinary vegetable food. 600 gm. of thymus per litre was used in each group for the preparation of the extracts. The extracts were made according to the method introduced by Hanson[7]. The vitamin B_{12} content of the sterile extracts filtered in a Berkefeld filter was determined with mutant *E. coli* strain 113–3 by the serial dilution method. The composition of the nutrient medium was as follows[8]: K_2HPO_4, 7·0 gm.; KH_2PO_4, 3·0 gm.; Na_3.citrate.$3H_2O$, 0·5 gm.; $MgSO_4.7H_2O$, 0·1 gm.; $(NH_4)_2SO_4$, 0·1 gm.; glucose (autoclaved separately), 10·0 gm.; and water, 1,000 gm.

The thymus extract of calves 2–4 weeks old contained 0·01 μgm. per ml. of vitamin B_{12}, that of calves 3–4 months of age contained 0·04 μgm. per ml. and the thymus extract of calves more than six months old contained 0·01 μgm. per ml. of vitamin B_{12}.

According to our results, the vitamin B_{12} content in thymus extracts is such that it can have a growth-promoting effect if the basal diet has been deficient as regards vitamin B_{12}. Hence, the vitamin B_{12} content of thymus may play a part in growth results obtained with thymus extracts.

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[1] Asher, L., *Wien. med. Wochenschr.*, **84**, 565 (1934).
[2] Rowntree, L. G., Clark, J. H., and Hanson, A. M., *J. Amer. Med. Assoc.*, **103**, 1425 (1934).
[3] Andreasen, E., and Hamburger, C., *Acta Anatomica* (Basel), **6**, 1 (1948).
[4] Segaloff, A., and Nelson, W. O., *Endocrin.*, **29**, 483 (1941).
[5] Hammar, J. A., "Die Normal-Morphologische Thymusforschung" (J. A. Barth, Leipzig, 1936).
[6] Lewis, U. J., Register, U. D., and Elvehjem, C. A., *Proc. Soc. Exp. Biol. and Med.*, **71**, 509 (1949).
[7] Hanson, A. M., *J. Amer. Med. Assoc.*, **94**, 653 (1930).
[8] Diding, N., *Scandinav. J. Clin. and Lab. Invest.*, **3**, 215 (1951).

Effect of Dietary Penicillin on Blood Composition and Œstrogen-induced Oviduct Growth in the Folic-Acid Deficient Chick

Studies designed to elucidate the processes responsible for the growth-promoting effects of dietary antibiotics have shown that the growth-rate of chicks and rats deficient in individual vitamins is increased by addition of an antibiotic. Growth responses to antibiotics on adequate diets have also been shown to be accompanied by increases in blood and liver concentrations of certain vitamins[1]. It has been pointed out by Coates *et al.*[2] that such increases may be non-specific to antibiotic treatment and may merely accompany a growth acceleration. Common *et al.*[3] demonstrated an increase in the blood levels of calcium and riboflavin in œstrogen-treated pullets as a result of adding aureomycin to an adequate diet. On the basis of experiments by Hertz *et al.*[4] such an increase could be attributed to an increase in dietary availability of these nutrients. In view of these remarks concerning the difficulty in interpreting such increases in blood- and tissue-

levels of a particular metabolite resulting from the inclusion of an antibiotic which also causes a growth stimulation, the two criteria of folic acid availability chosen in the experiment reported here were end-organ response to œstrogen and hæmoglobin-level in the blood. A short period of œstrogen treatment affects both blood composition and oviduct growth-rate, and the latter has been shown to be specifically reduced by folic-acid deficiency[5].

For the experiment eighty Light Sussex female chicks were reared for two weeks on a commercial chick mash and then placed on a purified folic-acid deficient diet similar to that of Lillie and Briggs[6], with the addition of vitamin B_{12} ('Distivit') at a level of 5 μgm./100 gm. The chicks were maintained on this diet for two weeks and then allocated at random to two groups of equal number and balanced for live-weight. One of these groups was fed procaine penicillin at a level of 20 mgm./kgm. diet for a further period of seven days, while the other group was maintained on the control diet. Both groups were offered the same amount of food, which they consumed completely. The chicks in each group were then weighed individually and allocated at random to three groups, each of twelve chicks, for hormone and folic-acid treatment over a further period of four days. The treatments given to the three groups on the control and the penicillin diet are shown in the accompanying table. Each group consumed the same amount of food daily, and during this time folic acid and œstradiol dipropionate were given by intramuscular injections on the first and third days at the levels shown.

Group	1	2	3	4	5	6
No. of chicks	12	12	12	12	12	12
Final body weight (gm.)	611	617	620	624	615	617
Procaine penicillin (mgm./kgm. diet)	Nil	20	Nil	20	Nil	20
Œstradiol dipropionate (mgm.)	Nil	Nil	2×2·0	2×2·0	2×2·0	2×2·0
Folic acid (mgm.)	Nil	Nil	Nil	Nil	2×0·5	2×0·5
Hæmoglobin (gm./100 ml.)	8·72	9·70	9·41	10·35	10·43	10·54
Oviduct weight (gm.)	0·088	0·095	1·876	2·161	2·818	2·898
Serum riboflavin (μgm./ml.)	—	—	0·29	0·65	0·19	0·44
Significance of difference between penicillin and control groups:						
Hæmoglobin	$P < 0·01$		$P < 0·001$		Not significant	
Oviduct weight	Not significant		$P < 0·05$		"	
Serum riboflavin	—		$P < 0·01$		$P < 0·05$	

The results show that the inclusion of penicillin in the deficient diet was accompanied by significant increases in hæmoglobin-levels in the blood of both control and œstrogen-treated chicks. The significant increase in the weight of oviduct of the chicks in group 4 as compared with group 3 is in agreement with this observation. Such increases in the weight of oviduct resulting from folic acid supplementation, as in groups 5 and 6, have been shown by me to be paralleled by an increase in dry weight and nitrogen content.

The higher serum riboflavin content of the penicillin-treated chicks receiving œstrogen confirms the observation of Common *et al.*[3], and shows that such changes in blood composition as a result of œstrogen treatment are unrelated to the specific failure of end-organ response attributable to a deficiency of folic acid. It would seem from this experiment that the addition of penicillin to the diet can result in a functional increase in folic-acid activity, as judged by the criteria cited above.

I am indebted to the Distillers Company (Biochemicals), Ltd., for the gift of procaine penicillin and vitamin B_{12}.

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[1] Burgess, R. C., Gluck, M., Brisson, G., and Lauchland, D. H., *Arch. Biochem. Biophys.*, **33**, 339 (1951).
[2] Coates, M. E., Harrison, G. F., Kon, S. K., Porter, J. W. G., and Thompson, S. Y., *Chem. and Indust.*, No. 7 (1952).
[3] Common, R. H., Keefe, T. J., Burgess, R., and Maw, W. A., *Nature*, **166**, 992 (1950).
[4] Hertz, R., Dhyse, F. G., and Tullner, W. W., *Endocrinol.*, 44, 283 (1949).
[5] Hertz, R., *Endocrinol.*, **37**, 1 (1945).
[6] Lillie, R. J., and Briggs, G. M., *Poultry Sci.*, **26**, 295 (1947).

Adsorption and Hæmolytic Action of Diacetyldeoxycholate

In an investigation of the relation of the hæmolytic activity of sodium cetyl sulphate and sodium lauryl sulphate to their adsorption to red blood cells, we found that hæmolysis only starts when a minimum quantity of the detergent is really fixed to the cell walls[1,2]. On the assumption that such hæmolysis does not necessarily involve a unique mechanism, we undertook the study of the relationship between hæmolysis and adsorption for a bile acid derivative.

Ponder[3] concluded from his experiments that sodium taurocholate reacts with some definite component of the cells which is solubilized, but that the lysin is not bound to the walls. After equilibrium it was found that the sodium taurocholate concentration, which was estimated colorimetrically, had remained constant, but the hæmolytic activity of the supernatant fluid had decreased enormously. We determined by the same technique the adsorption of radioactive deoxycholate, which was obtained by acetylation of deoxycholic acid with anhydric acetic acid labelled with carbon-14. A dilution series of the labelled lysin with borate buffer (*p*H 7·4) and a constant number of red cells (7×10^9 in a total volume of 8 ml., bovine blood) were separated by centrifugation after four hours. The distribution of the deoxycholate was estimated both in the red cells and in the solution by measuring its specific activity, and the rate of the hæmolysis was recorded (Table 1).

Adsorption in this case is also found to be positive, and hæmolysis starts only after a critical quantity of lysin has been bound to the cells. This corresponds to an adsorption of $0·45 \times 10^8$ molecules of diacetyl deoxycholic acid per cell for 50 per cent hæmolysis. A figure of $1·0 \times 10^8$ molecules per cell was found for both alkyl sulphates[2].

Table 1

Quantities of diacetyldeoxycholate In initial solution (γ/ml.)	Bound to the cells (γ)	Hæmolytic rate (per cent)
4·800	250	88
4·000	242	38
3·200	234	6
2·400	210	4
1·600	212	3

Table 2

Time (min.)	Hæmolytic rate (per cent)	Diacetyldeoxycholate bound to the cells
0	3	352
5	10	364
30	15	408
60	20	479
225	25	528
390	50	520

In the case of the alkyl sulphates, it was not possible to follow the adsorption-rate with time as the adsorption speed was too high; but in the case of deoxycholate it was possible to relate the time function of adsorption and hæmolytic rate using the same technique (Table 2).

We find evidence here of further development of hæmolysis after an initial rapid adsorption of the main quantity of the diacetyldeoxycholate.

The failure of Ponder to find adsorption of sodium taurocholate in a hæmolytic system can be explained by the recent results of Pethica and Schulman[4]. They found practically no hæmolytic activity for the highly purified compound and the activity was attributed to the accompanying impurities. A constant concentration of the taurocholate before and after the hæmolysis can thus be expected.

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[1] Ruyssen, R., and Croes, R., *Med. Kon. Vlaam. Acad. Wetensch. Belg.*, **12**, 4 (1950).
[2] Croes, R., and Ruyssen, R., *Bull. Soc. Chim. Biol.*, **33**, 1837 (1951).
[3] Ponder, E., "Hemolysis and Related Phenomena" (London, 1948).
[4] Pethica, B. A., and Schulman, J. H., *Nature*, **170**, 117 (1952).

Swarming of *Nereis succinea* (Leuckart) off the East Coast of Canada

In June 1952 the crew of a fisheries patrol boat cruising in Miramichi Bay, New Brunswick, observed what they took for a sand-bar in an unexpected situation. On closer inspection they found that there was no such bar, but that the surface of the sea over a wide area was in a state of violent turmoil ("a sort of boiling") due to the presence of enormous numbers of polychætes. The area covered was some 150 yards in radius and was broken up into several minor patches. The largest one, from which they took a sample of the polychætes, was estimated to be 75 ft. long and 15 ft. wide, and the polychætes seemed to extend to about 2 ft. deep. The tide was low at the time and the depth of the water about 7 ft. The bottom consisted of hard mud. The observation was made on a fine, warm day.

The polychætes involved were the heteronereid forms (both sexes) of *Nereis succinea* (Leuckart). This is the first record of that species from eastern Canadian waters, though it is known from the eastern coast of the United States, usually under the name *Nereis limbata* Ehlers. Ehlers[1] described in detail the male heteronereid of *Nereis acutifolia* Ehlers, which appears to be another synonym of *Nereis succinea* (Leuckart) (cf. Monro[2]). The specimens from Miramichi Bay agree closely with Ehlers's description.

We know of no other case of the swarming of a nereid with such activity and in such concentrated masses as occurred in this instance, and should be glad to hear of any that has been recorded.

The specimens were submitted by the collectors to Mr. R. A. McKenzie, a representative of the Fisheries Research Board of Canada at Chatham, New Brunswick, and were forwarded by him to Dr. A. H. Leim, of the Atlantic Biological Station, St. Andrews, New Brunswick, who, in turn, sent them to us for identification. We are indebted to the former for particulars of the conditions of swarming.

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[1] Ehlers, E., "Die Polychaeten des magellanischen und chilenischen Strandes", 118 (1901).
[2] Monro, C. C. A. *Proc. Zool. Soc.*, Pt. 1, 42 (1933).

Factors affecting Choice and Judgment

Dr. R. G. Hopkinson[1], in his account of a meeting of Section J of the British Association at Belfast, discusses certain aspects of subjective assessments. While admitting that subjective judgments can be of very real value, it does seem that Hopkinson has under-estimated some of their disadvantages in comparing them with 'objective' methods of measurement.

When subjective and objective methods of measurement can equally well be used, it may well be that, in certain cases, smaller differences can be detected by the subjective method. The 'success' of subjective assessments, however, is generally described in terms of accepted threshold-levels (generally 80 per cent correct), and there may have to be a relatively very large difference between stimuli before they can be distinguished 100 per cent correctly. In fact, a 100 per cent discrimination may be unattainable by subjective methods.

It is above all when absolute judgments have to be made, however, that subjective methods become inefficient. This is because a subjective judgment tends to be affected by others made just previously and, in particular, to be influenced by the average quality-level of the group within which the samples to be assessed are presented. Thus, for example, food products have often to be assessed by experts in terms of mental standards, when it is not possible to keep a standard sample for comparison purposes. In such a situation, Dove[2] has shown that a sample of sweet corn is described quite differently when presented with groups of samples differing in quality, and Sheppard[3,4] has shown that absolute judgments for firmness of a given sample are affected by the average firmness of the group within which it is judged.

It is interesting that Hopkinson found little variation in glare settings, since such judgments are likely to be more important biologically to the individual than the type of assessments described above, and it may be for this reason that they are made more accurately. Since fatigue mechanisms usually operate to safeguard the individual from physiological damage, it would be interesting if they could be shown to do so with a greater degree of accuracy than is usual in psychological assessments.

There are, however, other possible reasons for these differences. Thus it may be easier to maintain a mental standard for visual judgments than it is for flavour or tactual assessments; while it seems likely

that the criteria for glare ratings can be more successfully defined. A more probable explanation is that the stimulus range is (subjectively) wider for glare situations than for the others referred to and, since Hopkinson used a small number of rating values, it is for this reason that the subjective assessments appear to be reliable. The other possibility is that the difference can be attributed to the use of the 'method of adjustment' by Hopkinson, since this is not a commonly used psychophysical method.

There are two further disadvantages of absolute judgments made subjectively: the first is that the skill and knowledge required to make them have to be passed on by training, whereas an objective method of measurement can be precisely described in a written form, and can be used again after any period of time by anyone who is sufficiently skilled to construct and use the apparatus required. Secondly, fatigue may be important; thus, for example, a judge should not make more than five to seven assessments for flavour at one time. Instruments do not have this disadvantage.

With reference to Hopkinson's comments on the training of subjects to make judgments, Harper[5] has been able to show that relative discrimination, at least, can be improved by suitable training; but whether the factors influencing absolute judgments, as described above, can be overcome by suitable training, is less clear.

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[1] Hopkinson, R. G., *Nature*, **170**, 555 (1952).
[2] Dove, W. F., *J. Comp. Psychol.*, **35**, 29 (1943).
[3] Sheppard, D., *J. Dairy Res.*, **19**, 348 (1952).
[4] Sheppard, D., *Quart. J. Exp. Psychol.*, **5**, 1 (1953).
[5] Harper, R., *Brit. J. Psychol.*, Monog. Supp. No. 28 (1952).

Mr. Sheppard's letter directs attention to one of the many matters associated with subjective judgments that failed to receive consideration at the Belfast meeting, and I hope he will accept that my summary was concerned only with problems which arose out of the meeting itself. However, I am grateful for the opportunity which his letter affords to acknowledge that there are indeed situations where subjective judgments should be replaced by objective measures. I would go so far as to assert that, wherever the relation between the subjective reaction and the physical variables is fully understood, and the physical variables can be measured with the necessary degree of absolute and repetitional accuracy, the objective method should be used. For this reason we use, for example, photoelectric methods of photometry to replace visual methods, having satisfied ourselves that we understand the exact nature of the visual response to radiation of complex spectral characteristics inasmuch as it affects the ability of the eye to judge amount of light.

The need for subjective judgments arises when the relation between the physical variables and the subjective reaction is not fully understood. Then my contention is that it is often a wiser course to rely on a carefully planned series of subjective judgments than on a physical measure the inadequacy of which is hidden by its ability to repeat its judgments with apparent consistency. An instrument can be made which gives an objective reading which it correlates well with the subjective judgment of the 'graininess' of a cathode-ray tube screen, provided the same particle-size distribution of screen material is always used. Change the distribution, or the shape of particle, and the correlation breaks down. The instrument continues to churn out its apparently consistent readings, but these are no longer correlated with the subjective judgment they purport to replace.

The decision as to whether one should replace a subjective judgment by an objective measure should be based on the nature of the physical variables which govern the subjective reaction. Where one variable only is involved (for example, the amount of light on the recognition of the presence of a signal) or where only one variable can be assumed for the purpose to be involved (for example, the air temperature or the feeling of warmth when other factors are constant), this easily measured physical variable can be taken as an objective measure of the subjective quality.

In other situations the subjective quality can be linked with certainty to the physical variables, but the relation is so complex that only in special cases does the design and maintenance of an instrument based on it justify itself. Such a special case is the measurement of light of complex spectral quality, where a 'physical eye' of considerable complexity is needed in order that the manufacturer of fluorescent lamps may control his product.

Further up the scale are situations, like the judgment of paper quality, the characteristics of semi-diffusing materials for lighting, or the quality of wine, where only partial success has been achieved in establishing the complete range of physical variables which govern the subjective judgment. Such qualities can, however, be judged with accuracy, after training and experience, provided the judging is assisted and not deceived by the experimental conditions. It is in such cases that I query whether the time and effort expended in a search for an objective measure is justified.

Further still up the scale are judgments of æsthetic quality. Some of the physical factors which influence such qualities are understood—the proportions of a building, the order of progression of musical intervals, and so on—but the quality is essentially dependent on the weighting and integration, at a high level of thought, of a greater number of physical variables than could be handled at one time by any objective assessing-equipment at present within human conception.

It is probable that the clue to any remaining differences between Mr. Sheppard and myself is tied up in what we understand by a 'reliable' subjective judgment. He asks for every single judgment to be exact. I only ask that the mean of a convenient number of judgments should not drift, and that the variance of the judgments should be small in relation to the differences in which my experiment is interested. If this difficulty could be resolved, it might be possible to agree that some of the effort now devoted to the development of objective measures of complex situations might well be expended on the systematizing of a discipline for the conduct of subjective experiments and the training of human judges. There is still a great deal of prejudice which leads to distrust of experiments involving human judgments. This can be swept away only if the tools used in subjective experiments are sound, and are used in a way which commands respect.

R. G. Hopkinson

Building Research Station,
Watford, Herts.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 11

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. Koyré: "An Experiment in Measurement in the XVIIth Century" (Special University Lectures in the History and Philosophy of Science, 1).*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. J. A. Steers: "The East Anglian Floods".

Tuesday, May 12

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. Koyré: "An Experiment in Measurement in the XVIIth Century" (Special University Lectures in the History and Philosophy of Science, 2).*

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Annual General Meeting.

INSTITUT FRANCAIS DU ROYAUME-UNI (at 15 Queensberry Place, London, S.W.7), at 6 p.m.—Dr. P. Lépine (Paris): "Le Problème du Cancer dans ses relations avec les Virus".*

Wednesday, May 13

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Richard Southwell, F.R.S.: "Training for Science and Technology" (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. G. Y. Craig: "The Palaeoecology of the Top Hosie Shale, Kilsyth, Stirlingshire"; Dr. D. Flinn: "On the Time Relations between Regional Metamorphism and Permeation in Delting, Shetland".

BEDSON CLUB (in Lecture Theatre 1, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. J. H. Hildebrand: 91st Bedson Lecture.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Dr. R. Warnecke and Monsieur P. Guenard: "Recent Work in France on New Types of Valve for the Highest Radio Frequencies".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. W. H. J. Vernon: "Corrosion—a Field for Action" (Chairman's Address).

Thursday, May 14

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (at the Royal Institution of Chartered Surveyors, 12 Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

LABORATORY ANIMALS BUREAU (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 2.30 p.m.—Symposium on "Laboratory Animals".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. Cary Gilson: "The Freshwater Biological Association".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Annual General Meeting; at 8.30 p.m.—Dr. L. H. Gray: "The Initiation and Development of Cellular Damage by Ionizing Radiation" (Thirty-second Silvanus Thompson Memorial Lecture).

Friday, May 15

INSTITUTE OF NAVIGATION (joint meeting with the CHALLENGER SOCIETY, at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Dr. G. E. R. Deacon, F.R.S., and Commander G. S. Ritchie: "Navigation and Oceanography".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. Koyré: "Philosophical Factors in the Evolution of Science" (Special University Lectures in the History and Philosophy of Science, 3).*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Edwin Hubble: "The Observational Evidence for an Expanding Universe".

Friday, May 15—Saturday, May 16

PHYSICAL SOCIETY (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7).—Discussion on "Recent Research in Electron Optics".

Saturday, May 16

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (in the Arthur Worthington Hall, The University, Manchester), at 10 a.m.—Conference on "Photographic Science and Technique".

BIOCHEMICAL SOCIETY (in the Department of Physiology, The Medical School, Hospitals Centre, Birmingham), at 1.45 p.m.—Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. Harry Kay: "Remembering—some Recent Experiments".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ESSO STUDENTSHIP IN CHEMICAL ENGINEERING—The Registrar, University College, Gower Street, London, W.C.1 (May 15).

SENIOR LECTURER (with general experience of veterinary practice, and a particular knowledge of veterinary medicine in relation to farm animals and metabolic diseases) IN VETERINARY MEDICINE—The Secretary of University Court, The University, Glasgow (May 15).

ASSISTANT, Grade B (with honours degree) IN CHEMISTRY, to teach general chemistry up to Intermediate level and assist with teaching of physical chemistry to B.Sc. special standard, at Brighton Technical College—The Director of Education, 54 Old Steine, Brighton (May 16).

SENIOR LECTURER IN ORGANIC CHEMISTRY (with good honours degree in chemistry and, if possible, appropriate teaching, industrial and research experience, in pure or applied organic chemistry)—The Principal, Acton Technical College, High Street, Acton, London, W.3 (May 16).

SENIOR SCIENTIFIC OFFICER (university degree essential; experience in field experimentation and statistical analysis of results highly desirable), and an EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (must have at least N.D.A. or similar qualification, and practical experience with farm machinery essential)—The Secretary, Scottish Machinery Testing Station, Howden, Mid Calder, Midlothian (May 18).

READER IN PATHOLOGY at Westminster Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 19).

SUPERINTENDENT (Deputy Chief Scientific Officer) OF THE AERODYNAMICS DIVISION, National Physical Laboratory—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4201/53 (May 21).

ASSISTANT PHYSICISTS (Senior and Basic grades)—The Secretary, Sheffield Regional Hospital Board, Broom Cross, Tree Root Walk, Sheffield 10 (May 23).

BIOLOGICAL RESEARCH ASSISTANTS (2) at the Biological Research Institute, Grange-over-Sands (one to take entire responsibility for care and maintenance of the research laboratories, the other for survey and experimental work on soil fauna in the field and laboratory)—The Establishment Officer (A), Nature Conservancy, 91 Victoria Street, London, S.W.1 (May 26).

SCIENTISTS (physicists, physical chemists or electrical engineers with at least second-class honours degrees or equivalent, and interested in the physics and chemistry of surfaces) to undertake investigations on both laboratory and pilot plant scales into novel methods of separating coal from associated minerals (Ref. TT/624); a SCIENTIST, Grade II (Ref. TT/625); a SCIENTIST, Grade III (Ref. TT/626); and a SCIENTIFIC TECHNICAL OFFICER, Grade I (Ref. TT/627) to lead a small team engaged in the systematic measurement of the physical properties of coal and associated minerals, in the Physics Department—The National Coal Board, Central Research Establishment, Stoke Orchard, Cheltenham, Glos, quoting the appropriate Ref. No. (May 26).

AGRICULTURAL ECONOMISTS (2) and ASSISTANT AGRICULTURAL ECONOMISTS (2) in the Provincial Agricultural Economics Service—The Registrar, The University, Reading (May 30).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF GEOLOGY—The Registrar, The University, Liverpool (May 30).

LECTURER or ASSISTANT LECTURER IN PHYSICS (with good honours degree in physics)—The Dean, Medical School Office, Guy's Hospital, London, S.E.1 (May 30).

LECTURER IN EXPERIMENTAL PHYSICS—The Registrar, The University, Liverpool (May 30).

RESEARCH ASSISTANT (with at least two to three years experience in postgraduate research work) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (May 31).

RESEARCH BOTANIST (with good honours degree) for research on biennial bearing in fruit trees and other pomological problems—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (June 1).

SENIOR and JUNIOR FELLOWSHIPS—The Chief Superintendent, Telecommunications Research Establishment, Malvern, Worcs (June 1).

LECTURER and ASSISTANT LECTURERS (3) IN THE DEPARTMENT OF BIOCHEMISTRY (one appointment will entail research in certain physical aspects of biochemistry)—The Secretary, University College, Gower Street, London, W.C.1 (June 8).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF OCEANOGRAPHY—The Registrar, The University, Liverpool (June 13).

CHEMIST (Experimental Officer grade) (with pass degree or equivalent qualifications and substantial experience in routine chemical analysis) for mineral analysis of plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (June 15).

SENIOR LECTURER IN VETERINARY MEDICINE AND ANIMAL HEALTH, a LECTURER IN GRASSLAND ECOLOGY, a LECTURER IN AGRICULTURAL CHEMISTRY, and a LECTURER IN SOIL SCIENCE, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 27).

RESEARCH BOTANIST (with good honours degree and substantial postgraduate experience, preferably in perennial crops) IN THE POMOLOGY SECTION—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 31).

ASSISTANT PHYSICIST (with honours degree in physics) IN THE RADIOTHERAPY CENTRE—The Physician Superintendent, St. Luke's Hospital, Guildford.

ASSISTANT PROFESSOR OF PHYSICS (with a well-developed knowledge of geophysics, and established interest in fundamental geophysical research)—Prof. W. H. Watson, Department of Physics, University of Toronto, Toronto 5, Canada.

CHEMIST in the Public Works Department, Gold Coast, for the supervision of the purification of Government water supplies and investigation of new supplies—The Commissioners for the Gold Coast, Melbourne House, Aldwych, London, W.C.2.

JUNIOR ASSISTANT CHEMIST (with university degree including chemistry)—The Director, Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping Campden, Glos.

METALLURGISTS and METALLURGICAL ENGINEERS for (*a*) research on mild steel weld metal involving a relatively new problem of considerable interest and importance; (*b*) research on mild steel weld metal involving a constitutional approach to cracking problems; (*c*) research on the welding of high strength aluminium alloys—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

RESEARCH FELLOW IN HISTOCHEMISTRY—The House Governor and Secretary, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

SENIOR RESEARCH ASSISTANT (with good honours degree in engineering, practical experience and/or research training) IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

SENIOR SCIENTIFIC OFFICERS at Sellafield, Salwick and Culcheth, to lead research teams in theoretical and experimental work on the following: general physics and applied nuclear physics concerned with operation of nuclear reactors and associated processes, including health physics; physical and inorganic chemistry of metals and compounds used in atomic energy processes, including radioactive materials; extraction, purification and recovery of metals; refractory materials; physical metallurgy of radioactive metals; melting and casting of metals; X-ray crystallography of unusual metals and compounds—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 444.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Registrar General's Statistical Review of England and Wales for the Year 1951. (New Annual Series, No. 31.) Tables, Part 2, Civil. Pp. vii+181. (London: H.M. Stationery Office, 1953.) 5*s*. net. [53

London School of Hygiene and Tropical Medicine: Ross Institute Industrial Advisory Committee. Bulletin No. 8: Sanitation for Estate and Mine Labour Forces. Pp. 24. (London: London School of Hygiene and Tropical Medicine, 1952.) [53

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 901, Vol. 245: The Hartree-Fock Equations for Continuous States with Applications to Electron Excitation of the Ground Configuration Terms of O_1. By M. J. Seaton. Pp. 469–500. 7*s*. No. 902, Vol. 245: The Numerical Solution of Non-Singular Linear Integral Equations. By L. Fox and E. T. Goodwin. Pp. 501–534. 7*s*. 6*d*. (London: Cambridge University Press, 1953.) [53

Royal Technical College, Glasgow. Annual Report on the One Hundred and Fifty-sixth Session. Pp. 112. (Glasgow: Royal Technical College, 1952.) [53

University of Leeds. Annual Report of the Librarian, Session 1951–52. Pp. 16. (Leeds: The University, 1952.) [103

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1951–52. Kenya. Pp. 6. 9*d*. Northern Nigeria. Pp. 26. 9*d*. Southern Rhodesia. Pp. 8. 9*d*. Queensland. Pp. 12. 9*d*. West Indies. Pp. 18. 9*d*. (London: Empire Cotton Growing Corporation, 1953.) [103

Ciba Foundation for the Promotion of International Co-operation in Medical and Chemical Research. Report 1952. Pp. 43. (London: Ciba Foundation, 1953.) [103

Carnegie United Kingdom Trust. Thirty-ninth Annual Report, 1952. Pp. viii+32. (Dunfermline: Carnegie United Kingdom Trust, 1953.) [103

Forestry Commission. Forest Record No. 16: The Effects of Partial Soil Sterilization with Formalin on the raising of Sitka Spruce and other Conifer Seedlings. By M. V. Edwards. Pp. 20. 1*s*. 6*d*. net. Forest Record No. 18: The Use of Large Diameter Wheels and Tyres on Forest Extraction Vehicles. By R. G. Shaw. Pp. 8. 9*d*. net. (London: H.M. Stationery Office, 1952–1953.) [103

University of Leeds. Forty-first Annual Report, 1951–52. Pp. 66. (Leeds: The University, 1953.) [113

Royal Photographic Society of Great Britain. Library Catalogue, Supplement to Author Catalogue, 1939. Pp. 41. (London: Royal Photographic Society, 1952.) [113

Other Countries

East African Meteorological Department. Memoirs, Vol. 2, No. 10: Reports on Experiments at Kongwa on Artificial Control of Rainfall, January–April 1952. By D. A. Davies, D. Hepburn and Dr. H. W. Sansom. Pp. 14+8 plates. (Nairobi: East Africa High Commission, 1952.) 4*s*. [43

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes rendus des recherches, No. 9: Travaux du Centre National de Recherches Herbagères et Fourragères. Pp. 181. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1953.) 120 francs. [43

Fisheries Research Board of Canada. Bulletin No. 94: Freshwater Vertebrates of the Arctic and Subarctic. By V. C. Wynne-Edwards. Pp. iii+28. (Ottawa: Fisheries Research Board of Canada, 1952.) 30 cents. [43

Race and Class in Rural Brazil. Edited by Charles Wagley. (Race and Society Series.) Pp. 160+8 plates. (Paris: Unesco; London: H.M. Stationery Office, 1952.) 350 francs; 7*s*. 6*d*.; 1.25 dollars. [53

Fifth Annual Report of the Pacific Marine Fisheries Commission for the Year 1952. Pp. 19. (Portland, Ore.: Pacific Marine Fisheries Commission, 1953.) [53

Smithsonian Miscellaneous Collections. Vol. 12, No. 5: Solar Variation and Precipitation at Albany, N.Y. (Publication 4103.) Pp. ii+16. (Washington, D.C.: Smithsonian Institution, 1953.) [53

Smithsonian Institution: Bureau of American Ethnology. Bulletin 153: La Venta, Tabasco; a Study of Olmec Ceramics and Art. By Philip Drucker; with a Chapter on Structural Investigations in 1943, by Walde R. Wedel, and Appendix on Technological Analyses, by Anna O. Shepard. Pp. x+257+66 plates. (Washington, D.C.: Government Printing Office, 1952.) 1.25 dollars. [53

A New Direction in the Asthma Treatment based on the Theory of the Movement of Tension in Parasympathetic Nervous System. By Dr. Masuichi Takino. Pp. viii+80. (Osaka: Dainippon Zoki Kenkyusho Co., Ltd., 1952.) [53

Institut National pour l'Étude Agronomique du Congo Belge. Série Technique No. 41: Composition chimique et valeur papetière de quelques espèces de bambous récoltées au Congo Belge. Par J.-R. Istas et J. Hontoy. Pp. 24. 25 francs. Série Scientifique No. 54: Étude physicochimique des surfaces des argiles; les combinaisons de la kaolinite avec les oxydes du fer trivalent. Par Dr. J.-J. Fripiat et M.-C. Gastuche. Pp. 60+20 plates. 50 francs. Série Scientifique No. 53: Contribution à l'étude chimique des bois du Mayumbe. Par J.-R. Istas et E. R. Raekelboom. Pp. 122+17 plates. 100 francs. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1952.) [53

Institut National pour l'Étude Agronomique du Congo Belge: Bureau Climatologique. Communication No. 6: Sur le caractere organise de la pluie au Congo Belge. Par Dr. F. Bultot. Pp. 16+3 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1952.) 80 francs. [53

Fieldiana. Botany, Vol. 28, No. 2: Contributions to the Flora of Venezuela. By Julian A. Steyermark and collaborators. From Droseraceæ through Umbelliferæ. Pp. 241–447. (Chicago: Chicago Natural History Museum, 1952.) 4 dollars. [53

Inter-American Tropical Tuna Commission. Annual Report for the Years 1950 and 1951. Pp. 58. (La Jolla, Calif.: Inter-American Tropical Tuna Commission, 1952.) [53

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expedition. Interim Reports, 3: The Status of the Leopard Seal at Heard Island and Macquarie Island, 1948–1950. By A. M. Gwynn. Pp. ii+33+3 plates. Interim Reports, 4: Notes on the Fur Seals at Macquarie Island and Heard Island. By A. M. Gwynn. Pp. 11+16+6 plates. (Melbourne: Department of External Affairs, 1953.) [53

United States Department of Commerce: National Bureau of Standards. NBS Circular 535: An Annotated Bibliography of Selected References on the Solid-State Reactions of the Uranium Oxides. By S. M. Lang. Pp. iv+95. (Washington, D.C.: Government Printing Office, 1953.) 30 cents. [53

World Health Organization. Technical Report Series No. 54: Expert Committee on Insecticides; Fourth Report. Pp. 98. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 2.60 Swiss francs; 5*s*.; 65 cents. [53

Smithsonian Miscellaneous Collections. Vol. 121, No. 3: A Revision of the Colombian Species of Monnina (Polygalaceæ). (Publication 4100.) Pp. ii+59. (Washington, D.C.: Smithsonian Institution, 1953.) [53

Publications de l'Institut National Turc de Bibliographie. Bibliographie des articles parus dans les periodiques Turcs. 1952, 1, Mars. Pp. 124. 1952, 2, Avril-Mai. Pp. 135. (Istanbul: Institut National Turc de Bibliographie, 1952.) [53

Uganda Electricity Board. Fifth Annual Report and Accounts for Year ended 31st December 1952. Pp. 40. (Kampala: Uganda Electricity Board, 1953.) 1*s*. [53

Reports and Accounts of the National Botanic Gardens of South Africa, Kirstenbosch, and the Karoo Garden, Worcester, for the Year ending 31 December 1952. Pp. 20. (Kirstenbosch: National Botanic Gardens of South Africa, 1953.) [53

Una nueva hipotesis acerca de la rotacion terrestre. Por Guido Buffo. Pp. 16. (Unquillo, Cordoba: The Author, 1951.) [53

National Research Council. Review, 1952. (N.R.C. No. 2852.) Pp. 271+12 plates. (Ottawa: National Research Council, 1953.) 75 cents. [53

Union of South Africa: Department of Agriculture. Science Bulletin No. 317 (Chemistry Series No. 191): A Maize—N-P-K Fertilizer Experiment, 1931–1937, by Dr. J. van Garderen and W. B. Goldschmidt; and A Break in the Phosphate Yield-Increment Curve, by Dr. J. van Garderen. Pp. ii+18. 3*d*. Science Bulletin No. 318 (Chemistry Series No. 192): Fertilizer Experiments (1938–1945) at the Vaal-Hartz Agricultural Research Station. By Dr. J. van Garderen and D. G. Wessels. Pp. 59. 6*d*. (Pretoria: Government Printer, 1951.) [53

Revista Ecuatoriana de Entomologia y Parasitologia. Vol. 1, No. 1, Enero 1953. Pp. 48. (Guayacuil: Centro Ecuatoriano de Investigaciones Entomológicas, 1953.) Annual subscription, 100 sucres; 5 dollars. [53

Publications of the Dominion Astrophysical Observatory, Victoria. Vol. 9, No. 4: The Spectroscopic Orbits of H.D. 100018 (A. D. S. 8189). By R. M. Petrie and Dorothy M. Laidler. Pp. 181–188+plate 2. 25 cents. Vol. 9, No. 5: A Spectrographic Study of the Eclipsing Binary 32 Cygni. By K. O. Wright. Pp. 189–218+plate 3. 25 cents. Vol. 9, No. 6: The Radial-Velocity Variations of ζ Tauri. By Anne B. Underhill. Pp. 219–236+plate 4. (Ottawa: Queen's Printer, 1952.) [53

Catalogues

Scientific Instruments. (Catalogue H.) Pp. 24. (Cambridge: W. G. Pye and Co., Ltd., 1953.)

Are you running a Temperature: the Fielden Electronic Resistance Bulb Multipoint Thermometer. (Leaflet No. 209.) Pp. 16. Fielden Electronic Resistance Thermometers. (Publication 209FE/13.) Pp. ii+22. Thermometer Bridge. (218FE/23.) Pp. 2. Electronic Thermostat. (219FE/23.) Pp. 2. (Manchester: Fielden (Electronics), Ltd., 1953.)